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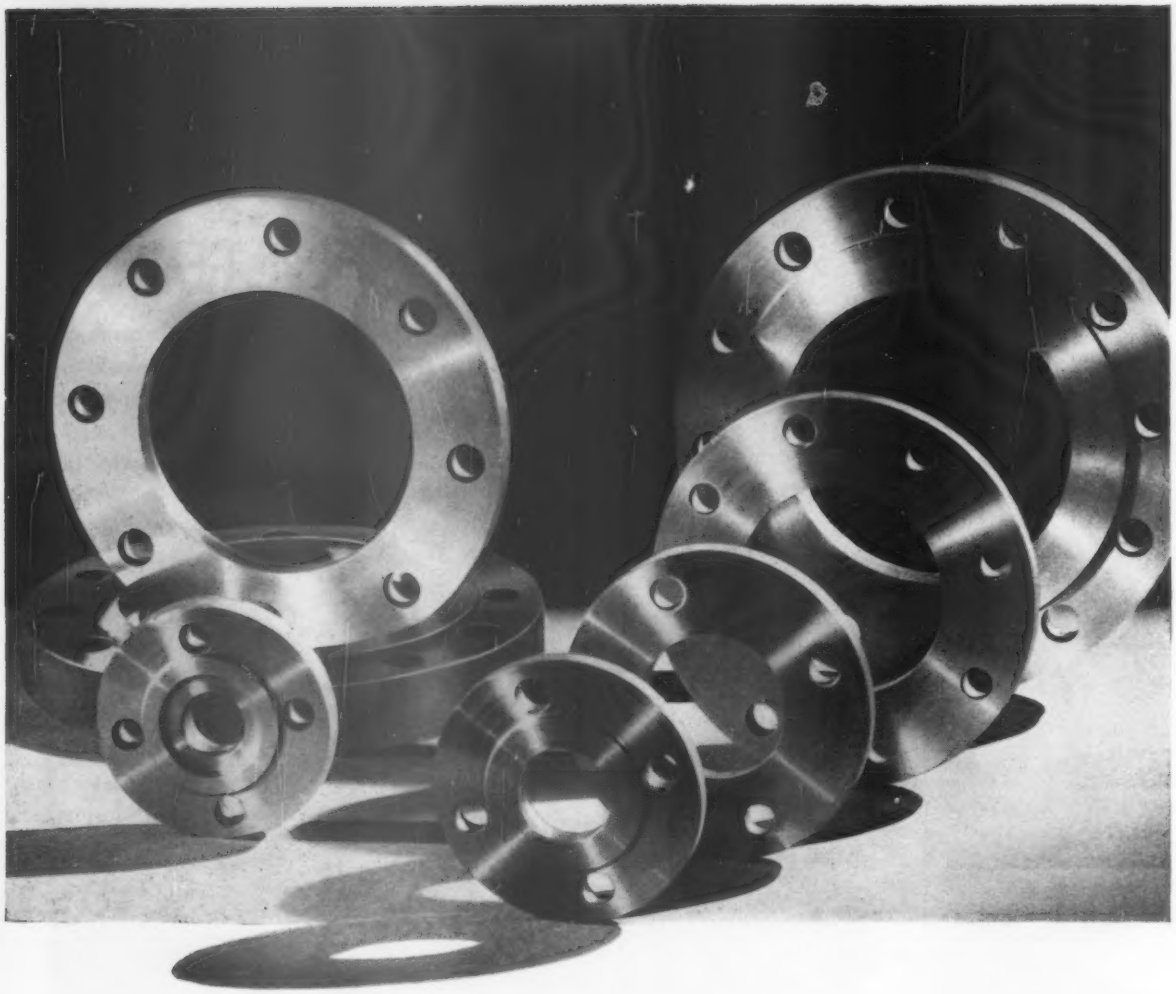

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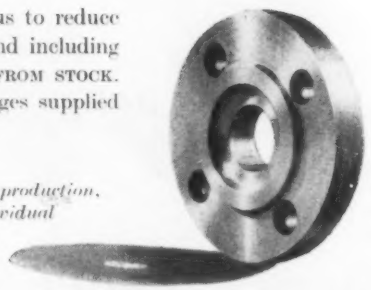

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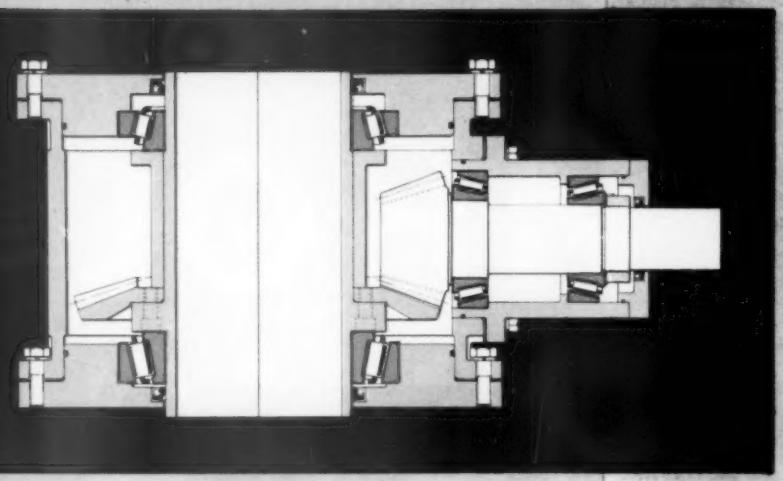

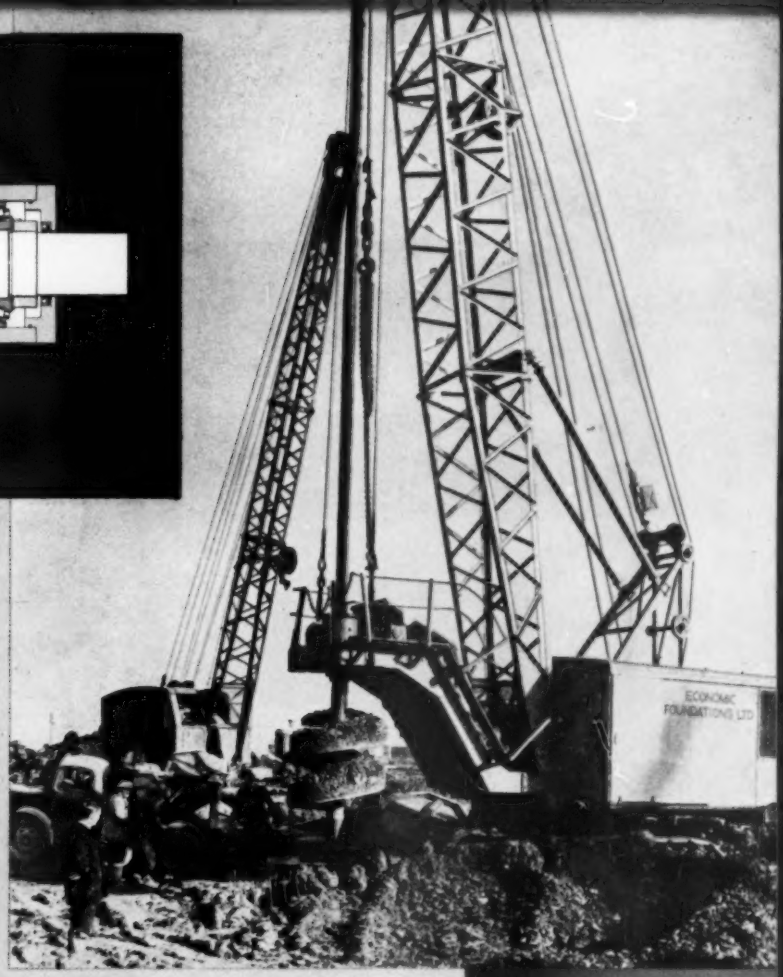

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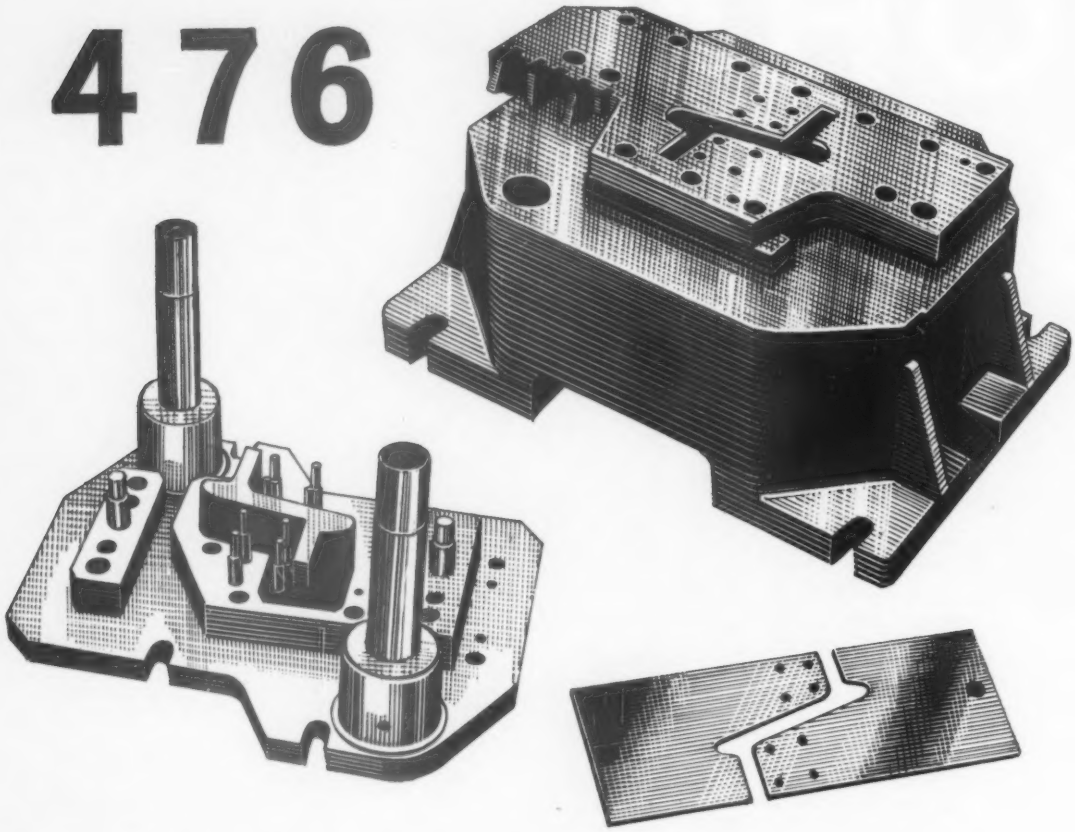

'476' Heavy duty die steel of the high carbon, high chromium type, has outstanding wear-resistance but is tough and machinable. It is particularly recommended for tools operating under conditions of severe wear and abrasion and where maximum runs are required.

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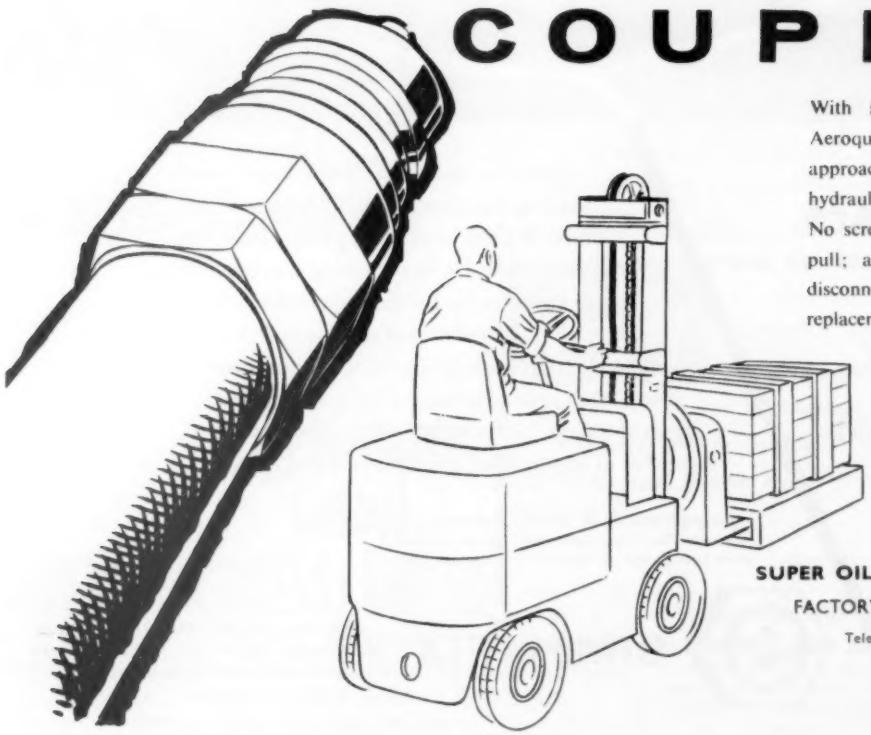

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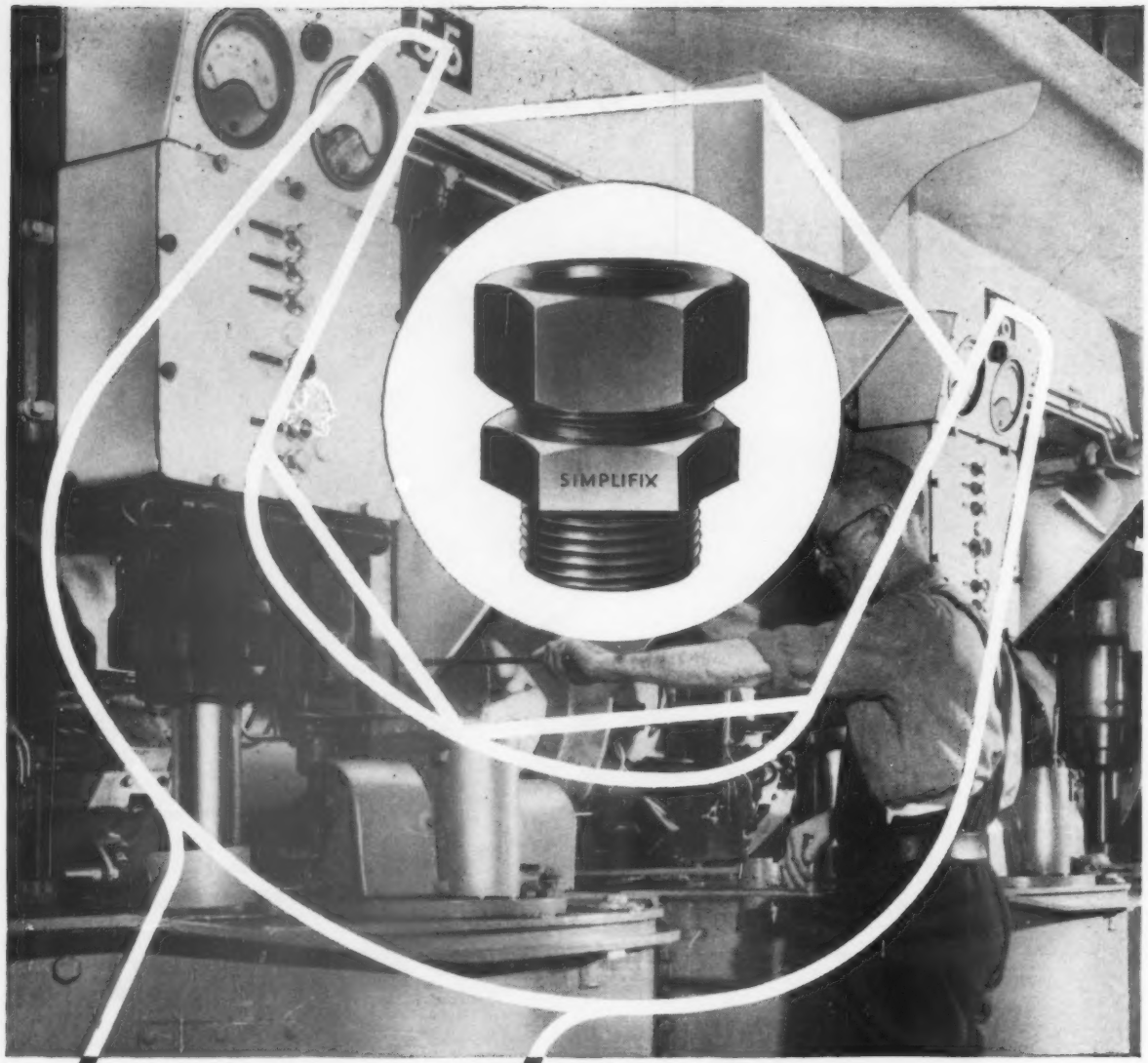

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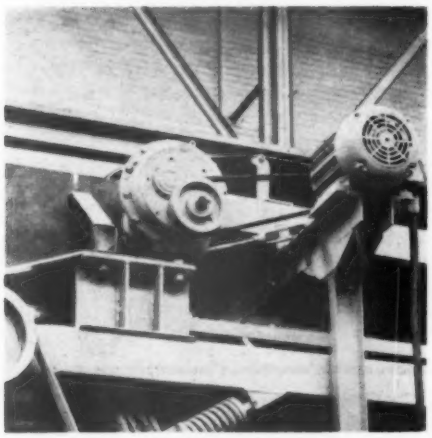

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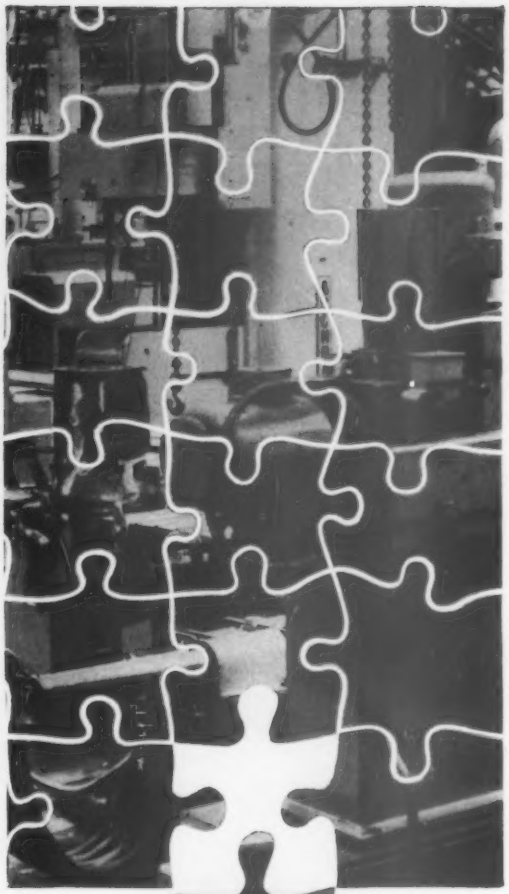

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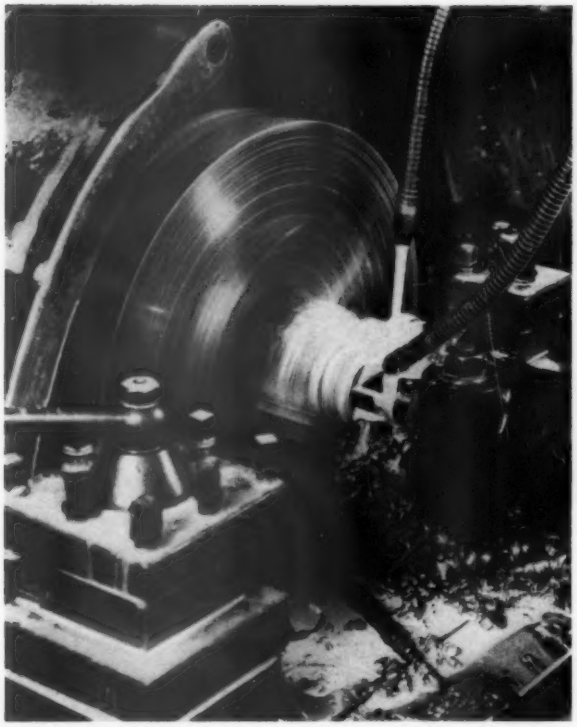

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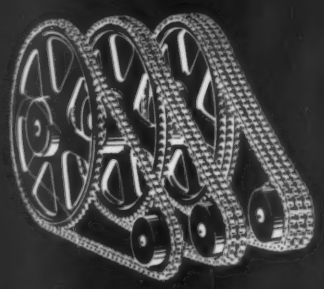

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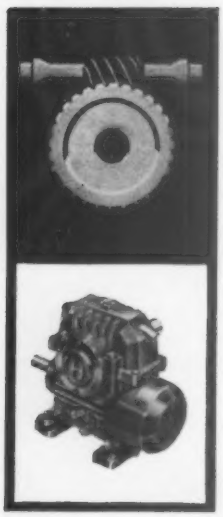

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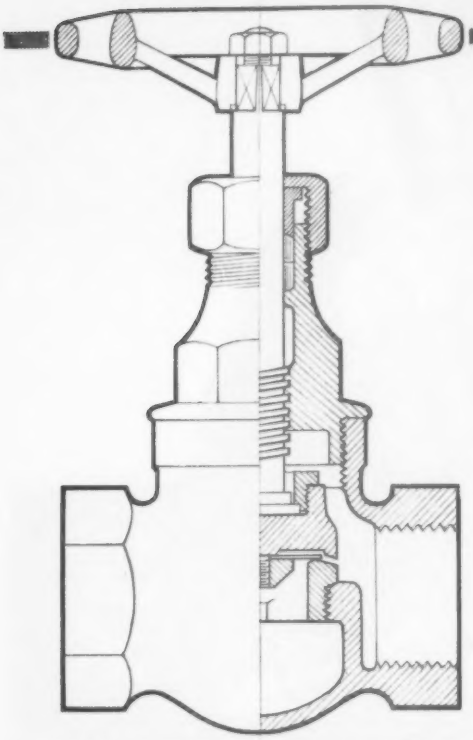

the Fig. 2016 'PRESEATOR' globe valve with the Flexible Titanium Disk*

This specially designed Hattersley valve incorporates a flexible pre-seating disk made of an I.C.I. titanium alloy which is exceptionally resistant to corrosion and erosion. As this seats before the main surfaces, pipe-scale is trapped and the main seating surfaces protected from the effects of wire drawing.

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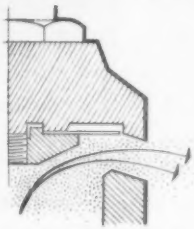
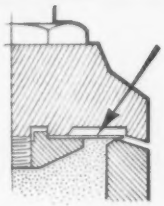
* *The Flexible Titanium Disk is protected by Patent No. 822147*

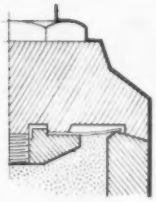
Over a period of years the outstanding merits of this Valve have been proved under the most arduous service conditions on many installations.



In open position free passage for flow directed across seating surfaces.



In 'Pre-shut' position flow and pipe scale held back by *Flexible Titanium Disk.*
Patent No. 822147



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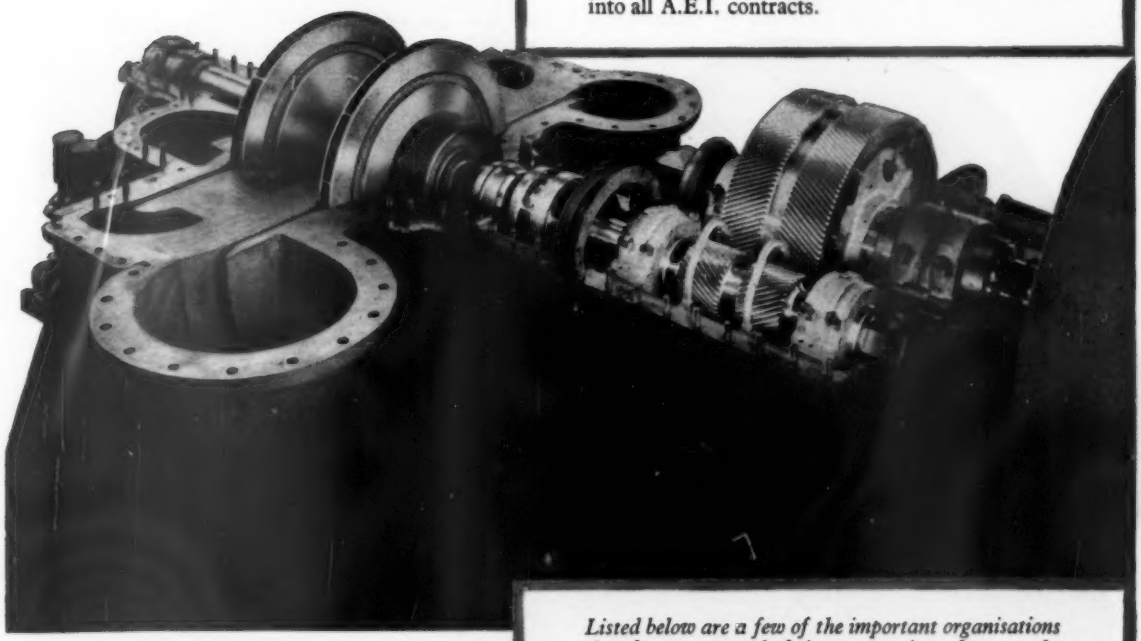

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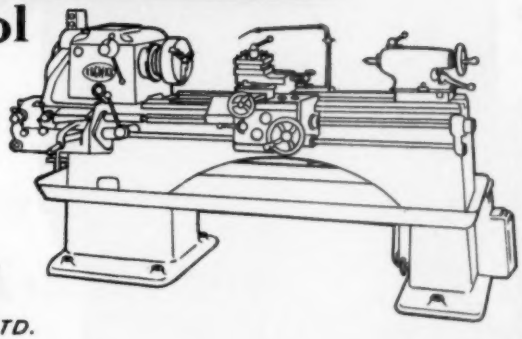

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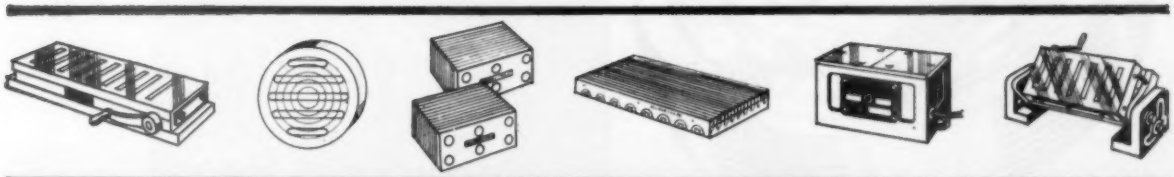

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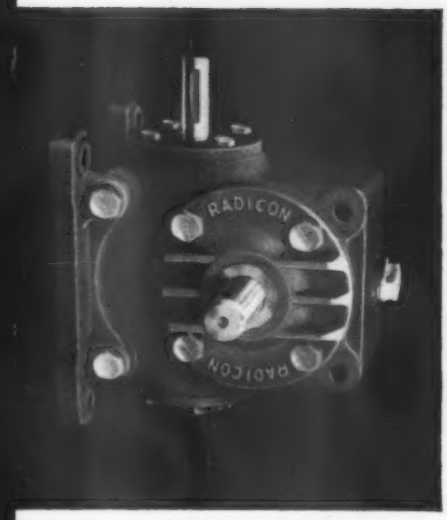

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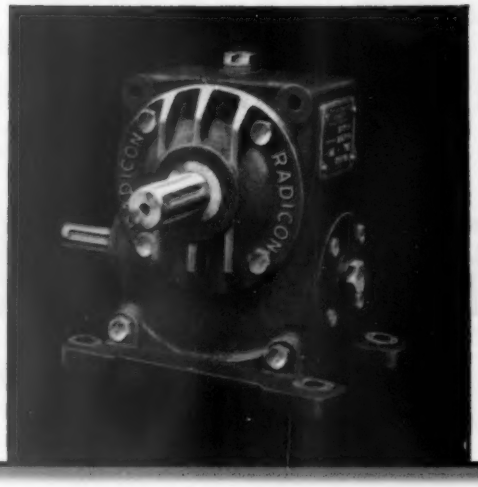

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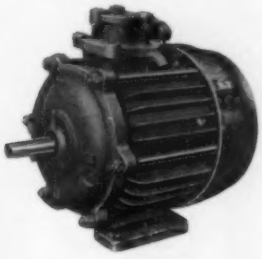

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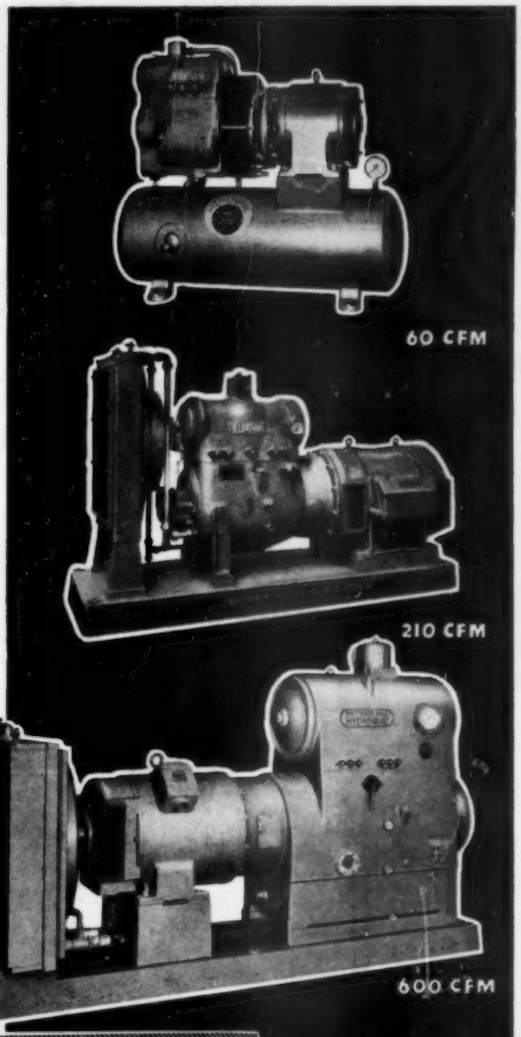

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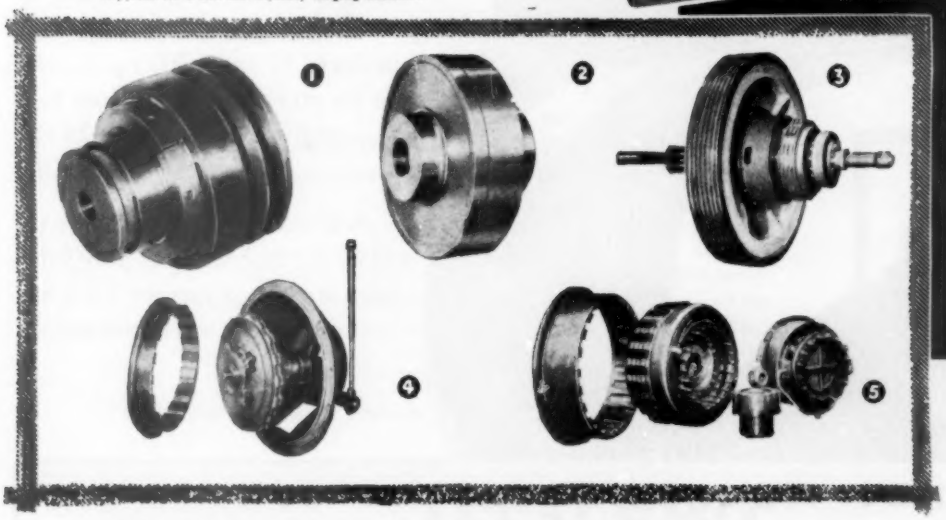

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N.B.—The illustration shows the drilling and spot facing of main fixing holes in end brackets for 250 b.h.p. electric motors.

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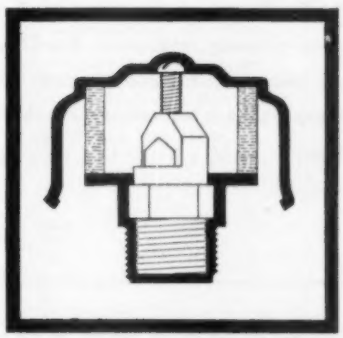

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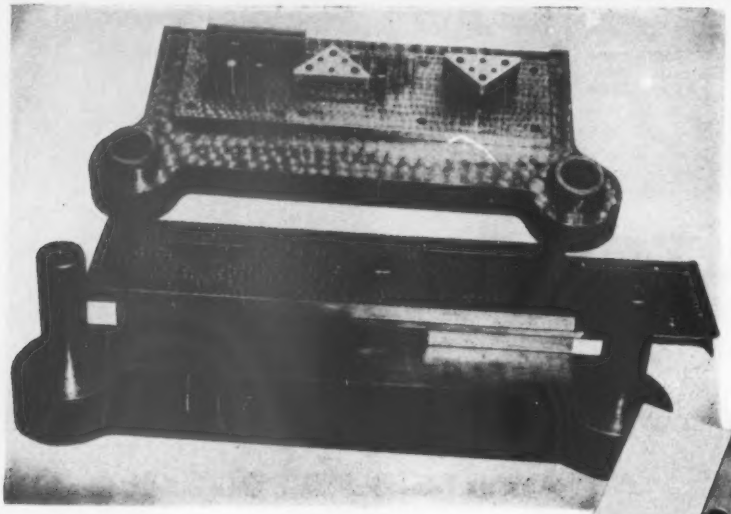

Follow-on tool for lock parts (courtesy: Lowe & Fletcher Ltd.) and piercing and blanking tool (courtesy: Brook Motors Ltd.) in Double Six Steel.

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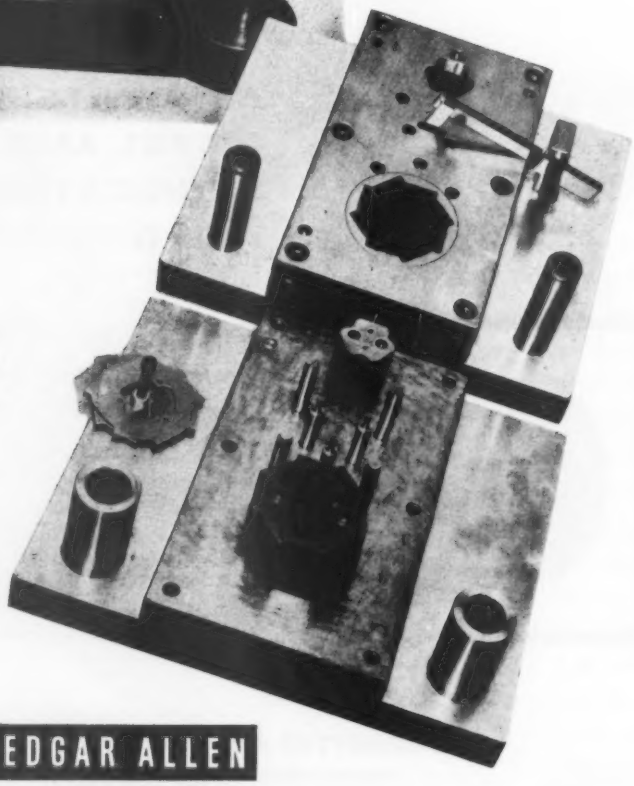

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One Engineering

WHEN Professor J. M. Kay commended the Junior Institution of Engineers (of which he is president) for conserving in its title the idea of the essential unity of engineering he upheld a truth which the present complexity of applied science tends to obscure. True, there are many kinds of specialist engineer, and there are many kinds of scientist, and they work together with sufficient harmony to perform prodigious feats of design and execution, but examine any large and complicated work carefully and it will be seen to be one co-ordinated piece of engineering which depends for its success on being treated as such right from its inception. A large building is the conception of an architect, but engineering design and construction is not something added but built into the idea from the start. A big chemical plant or oil refinery has its origin in a chemical process, but its reality as a producing unit depends upon its being a single engineering project from the start. Professor Kay said much the same about nuclear plants—they do not arise from "nuclear engineering" done by "nuclear engineers", but from good engineering backed by a knowledge of special nuclear problems. As Sir Christopher Hinton once said, "It is more important to be successful than to be clever".

LOG SHEET

Welding Design

In November last the British Welding Research Association inaugurated a Design Advisory Service the object of which is to show how research work can be applied at all stages of design, from the choice of right materials and selection of the most suitable welding process to the correct method of assembly.

Welding can be the most efficient method of fabrication from the viewpoint of speed, economy in materials and strength for weight provided the design is right. Several specimens prepared by B.W.R.A. showing typical cases of good and bad design for welding draw attention to the following general points:

(1) The difficulty of making satisfactory joints between rolled sections.—Use plates instead.

(2) The error of butt welding plates of different thicknesses.—Taper the thicker plates and keep weld away from point of section change.

(3) The avoidance of weld crossings or intersections.—Cut away corners of stiffeners.

(4) The bad stress concentrations arising from sharp changes of section.

(5) The incidence of severe notching at extremities caused by cover plates.—Better to taper the section in plan.

(6) Risks arising from the use of intermittent welds in regions of tensile stress.

(7) The avoidance of sharp corners. —Liberal radii reduce stress concentrations.

Largest Turbo-alternators

Work has been started by The English Electric Company Limited on the two largest single-shaft steam turbo-alternators yet to be built in Europe. Ordered by the Central Electricity Generating Board the job will be worth nearly £5 million and will cover the two 350 MW sets with their feed heating and evaporating plants.

The sets are to be installed in the Board's new Drakelow-C Power Station near Burton-on-Trent and the East Midlands coalfield; ultimately the total installed capacity of the station will be 1400 to 1500 MW.

The 350 MW unit includes a three-cylinder, 3000 rpm reheat turbine with quadruple exhaust arranged as a tandem compound unit coupled to a hydrogen/water cooled alternator of the direct-cooled type and fed by a John Thompson water tube boiler capable of evaporating nearly 1100 tons of water per hour to give 2400 psig steam at 1055° F. In the turbo-alternator, solid couplings are employed between cylinders, and each shaft is mounted on two main bearings so that the assembly and maintenance of the machine are kept as simple as possible.

DIESEL LOCOMOTIVE.—This is the first of the 20 type 2 (1000/1365 hp) diesel electric locomotives being built at Darlington by British Railways. Novel features include the use of light alloys, thinner steel plates in the engine and a generator without exciter. The engine is a 6-cyl Sulzer made by Vickers Armstrongs and the electrical equipment is by A.E.I.

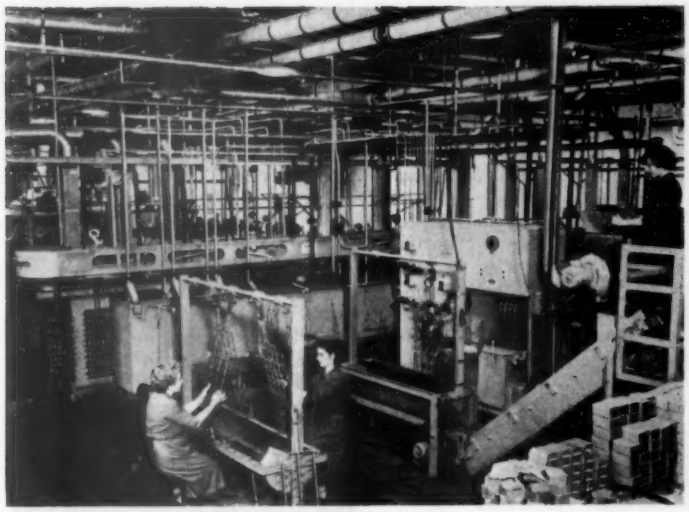
In line with modern developments the turbine operates with steam at 2300 psig, 1050° F at the turbine stop valve, with reheat steam returning from the boiler to the intermediate pressure cylinder at 1050° F. The vacuum at maximum and economic rating is 28·7 in. Hg (bar. 30 in.).

To meet the specified high pressure and temperature requirements, the high pressure cylinder employs a double casing over the first stages, with the expanded steam returned over the outside of the inner casing to pass through the remaining stages. These combined features enable the pressure differences and operating temperatures in the metal to be reduced, compared with those applied to a single casing design. The intermediate pressure cylinder has a partial double-casing construction. The quadruple flow L.P. cylinder is arranged in two double-flow L.P. casings, each casing exhausting to one of the two condensers forming the twin condenser unit.

Electric Arc Furnaces

All the existing open hearth steel melting furnaces are to be replaced by six electric arc furnaces of 110 tons capacity each at the Steel, Peech and Tozer branch of The United Steel Companies Limited. When completed in about five years' time, this will be the largest electric steelmaking plant in the world with an annual capacity of 1,350,000 ingot tons of steel. Costing £10 million it is also the largest single development scheme in the branch's eighty-year history.

At the present time there are twenty-one open hearth furnaces at the plant. Initially, four electric furnaces of the swing-roof type will be installed, and it is planned to have the first of these in commission by January, 1963. To maintain the existing level of steel production during the changeover double oil burners will be fitted to some of the furnaces and others converted to "all-basic" refractory linings.



General view of the new automatic plating machine which gives bright nickel or chromium finish to 30,000 parts per eight-hour shift. Operatives are seen loading manually in the foreground but loading and unloading will shortly be made automatic. At right is the final drying section

Automatic Plating

A new automatic plating machine at the Haydock (Lancs) factory of Thomas Crompton & Sons Limited will deal with up to 30,000 parts, with nickel or chromium in an eight-hour shift.

The machine, which has been supplied and installed by the Electro-Chemical Engineering Company Limited, Woking, Surrey, is manually loaded at present but provision is made for automatic loading in the near future. Parts are located on spring racks measuring approximately 30 in. by 12 in. The machine is constructed in three main sections, carried on rolled steel supports, which provide an air space below. Heating is effected by coils and a heat exchanger using steam at 40 psi.

Main processes are cleaning, pre-treatment, bright nickel and chromium. Approximately 0·0005 in. bright nickel finish is deposited in 11½ min at 60 amp/sq ft or a similar coating of chromium in 5½ min at 120 amp/sq ft.

Transfer of plating racks is carried out by hydraulic cylinders fed by a separate floor mounted oil pump and pressure assembly which is motor driven; a hydraulic drive control panel is embodied. Rectifiers and transformers are alongside, together with a final drying station.

Overall length of the complete installation is some 37 ft and the width 13 ft.

Automatic Feeding for Bar Reeling

New semi-automatic bar feeding and handling equipment recently installed in the works of Messrs. Pratt, Levick & Co. Limited, Chester, has eliminated almost all of the hazards from the dangerous process of bar reeling.

This equipment, which was designed and manufactured by the Automation Division of The Hymatic Engineering Company Limited, Redditch, Worcs, feeds round bars of $\frac{9}{16}$ in. to 1½ in. dia to a reeling machine, and extracts and ejects reeled bars from the output end of the machine. Whipping of the bars during the reeling process, which is one of the greatest dangers in any bar preparation process, is now completely eliminated. Full interlock protection is incorporated in the pneumatic and electrical circuits giving added protection to both operator and equipment.

Only one semi-skilled feeder is needed to control the equipment, instead of two or three previously employed, and a very heavy manual job has been reduced to a relatively light operation. As the equipment handles the bars automatically, the feeder can start preparing the next bar as soon as the first has entered the rollers. This gives a much higher machine utilization factor.

The equipment can handle a two ton load of bars, which is deposited on separate rails by an overhead crane. The feeder then selects a bar and rolls it part-way down a set of inclined rails until it rests in a set of V's located in the rails. A set of freely running V-rollers then lifts the bar to the height of a chamfering machine head. The feeder pushes the bar forward into the chamfering machine, where it is automatically gripped and machined.

When the bar is released the feeder withdraws it, lowers the V-rollers and rolls the bar down a short length of inclined rail until it falls into open clapper-boxes. These are, in effect, tunnels formed by lengths of channel iron, one on top of the other, with their open sides facing each other. Hardwood linings are fitted into all the clapper-boxes.

The feeder then closes the clapper-boxes by means of a pneumatic control valve and, similarly, causes a pair of pinch-rollers, located at the forward end of the equipment, to grip the bar and feed it forward into the reeling rolls. An automatic device is fitted which retracts the pinch-rollers just before the bar is engaged by the rollers.

On leaving the rolls on the exit side, the bar enters another series of clapper-boxes which prevent it from whipping. As the trailing end of the bar leaves the reeling machine, a further pair of pinch-rollers automatically withdraw it clear of the working area.

These rollers then open and the clapper-boxes open to release the bar. The clapper-box opening also raises a set of inclined ejection rails, which are situated at intervals along the clapper-boxes. These rails lift the finished bar clear of the boxes and allow it to roll down on to a transit stillage.

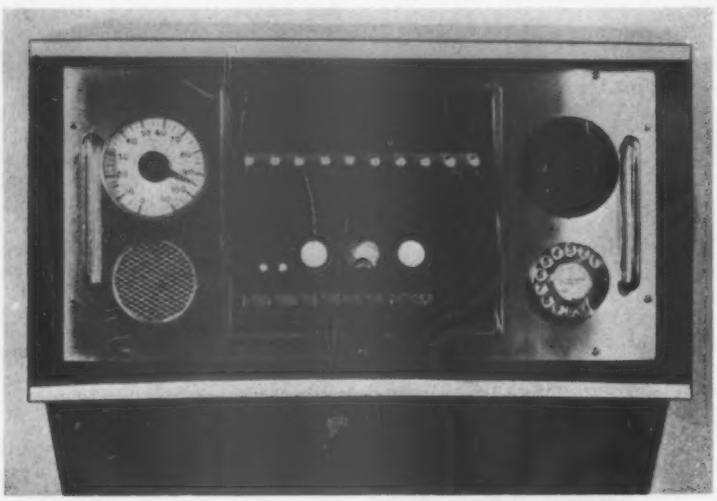
The equipment is operated from a 3-phase, 50-cycle electrical supply and an air supply of 70–100 psi.

Durgapur in Action

Last December saw the completion of the first stage of the Durgapur Steelworks in West Bengal. Subsequent stages will be reached this year and next, the plant being scheduled for completion by July 31 of 1961. The contract, worth approximately £105 million, is the largest single export order ever obtained by Great Britain and is being carried out by the Indian Steelworks Construction Company Limited, ISCON, a consortium formed specially for the purpose by 13 firms.

The rolling mills, wheel and axle plant, foundry and central

engineering maintenance shop, are being supplied by Davy and United Engineering Company Limited, the blast furnaces and iron making plant by Head Wrightson & Co. Limited, the coke ovens and by-products plant, power plant, steam and gas distribution plant by Simon-Carves Limited, the open hearth furnaces and steel making plant, cranes and soaking pits by The Wellman Smith Owen Engineering Corporation Limited, and the civil engineering work, except for the coke ovens and power plant, is being done by The Cementation Company Limited. The electrical work is shared by four firms—the Manchester and Rugby Branches of Associated Electrical Industries Limited (Metrovick and B.T.H.), The English Electric Company Limited, and The General Electric Company Limited. The structural steel work is shared by four firms—Sir William Arrol & Co. Limited (who are also supplying the cranes), The Cleveland Bridge & Engineering Company Limited, Dorman, Long (Bridge & Engineering) Limited, and Joseph Parks & Son Limited.



REMOTE POWER CONTROL.—This panel contains all the controls necessary to operate and supervise the new unmanned "pocket" power station at Princetown, Devon, of the South Western Electricity Board. It is the first robot plant of its type in the world and the Datofonic control panel above is installed at the central office, Bristol. Instructions and information are exchanged over the 100 miles distance by a telephone call, made through the normal G.P.O. trunk call facilities. The Datofonic system is completely automatic and is suitable for installation as a packaged unit for any type of plant situated in remote areas. Datofonic is designed, developed and manufactured by Sound Diffusion (Auto-Thermatic) Limited, Duracraft Works, Portslade, Sussex

Automatic Mine Winding

An entirely overhung armature is being used in new tower-mounted friction winders at Warsop Colliery, No. 3 Area, N.C.B. East Midlands Division, by A.E.I. Heavy Plant Division. By so doing, it has been possible to employ only two main bearings, and thus accommodate the deflexion and distortion of the winder unavoidable in a steel-framed tower.

Men and materials only are wound in No. 1 shaft, and coal exclusively in No. 2, which, from the arrival of the coal train at the tippling station underground to discharging at the top of the shaft, has an automatic winding system. Automatic operation depends on the flow of coal from the face. The arrival of the skip at the underground filling station operates a magnetic proximity switch which begins the sequence of operations by loading coal into the skip and then switching the flow of coal from the tipplers to the appropriate measuring pockets.

The control system permits automatic winding to be carried out continuously, and safeguards are provided, so that, in the event of interruption in an emergency, the cycle of operations must be completed manually before automatic winding can be resumed. With the normal flow of coal, the skip is moved when it contains eight tons of coal. If, however, the supply of coal from the working is very slow, the arrangement is such that on both winders a positive pneumatic braking system is employed, which, in a simple and safe manner, performs the mechanical braking to the designed limits, irrespective of wear on the shoe lining. The brakes can be set to exert the correct effort for both normal and emergency operation when carrying out either normal winding or the rope changing duty.

The mechanical parts of the two winders, as well as the structural steelwork of the towers, were supplied by Guttehoffnungshutte—the structural work in consultation with Husband and Company, of Sheffield. Siemens Halske were also sub-contractors.

Increasing Gearbox

A speed increasing gearbox of special design, and with output gears believed to run at a higher pitch line speed than any hitherto made in Great Britain and perhaps in the world, has been completed by A.E.I. Heavy Plant Division and shipped to Canada. The gearbox was supplied through A.E.I. (Canada) Limited and is for the Canadian Pratt and Whitney Aircraft Company Limited, Montreal, who will use it for development work on gas-turbine aircraft engines. The gearbox transmits 2000 hp with a speed increasing ratio of 1700/44,840 rpm. It is, however, designed to allow for future modification which will give an output speed of 55,000 rpm. The order for this equipment was obtained in the face of strong competition from United States manufacturers. Design and manufacture was completed in five months.

A.E.I. gearbox of special design for Canada. It transmits 2000 hp with a speed increasing ratio of 1700/44,840 rpm

Terylene in V-belts

Terylene-reinforced premium V-belts are now available from many leading manufacturers and are already being used in widely varying conditions, from ½ hp machines up to 600 hp compressors. In most cases they have lasted twice, and in some cases five times as long as standard belts, and because Terylene is so strong it has often been possible to use fewer belts on existing drives,

while on future drives designed to incorporate fewer belts, the new construction may mean considerable saving in space and money. Terylene reinforced V-belts do not stretch much and have dimensional stability and anti-static properties, and resist heat, oil and shock loading.

The Glacier Metal Company Limited changed to Terylene reinforced V-belts on its bearing test rigs. Pulley speeds up to 6000 rpm and oil vapour temperatures of 180° F meant that standard belts were continually having to be replaced. Terylene reinforced V-belts lasted three times as long and have now been installed on all 21 test heads.

Bonnybridge Generating Station, Falkirk, has been testing Terylene reinforced V-belts on one of its coal handling plants, carrying a maximum of 60 tons of coal an hour. Three belts have lasted twice as long as seven standard belts did previously and in 19 months have needed no adjustment.

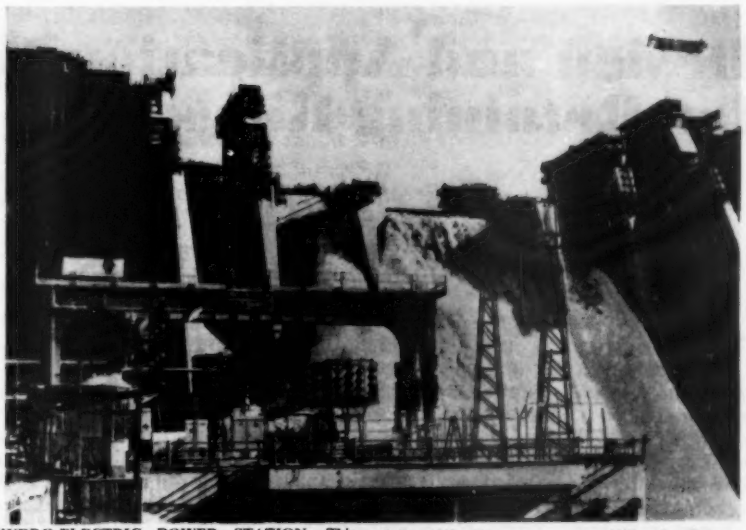
The Jaguar Car Company have standardized on Terylene reinforced V-belts for all drives in their paint shop. On a 40 hp 1470 rpm turbo blower at the Trafford Park Works of British Oil & Cake Mills, Terylene reinforced V-belts have lasted 14 months compared with three to four months for standard belts.

Terylene reinforced V-belts are between 30% and 40% more expensive than standard belts of the same size but their initial cost is claimed to be more than offset by their longer life and ease of maintenance.

Tunnelling Record

By advancing 107 yd 4 in. in seven days, a team of 24 National Coal Board tunnellers have set up a new British tunnel drivage record. This was accomplished in the week ending December 14 last year at the Bank Hall colliery, Burnley, in the North-Western Division of the N.C.B. The previous seven-day record was 105 yd 6 in. at the Agecroft colliery, Pendlebury, near Manchester, during the week ending August 30, 1959.

The Towneley tunnel at Bank Hall, in which the new record was established, has a sectional area of 21·5 sq yd and is 1,500 ft below ground, rising 1 in 200 and is situated about 5,000 ft from the shaft. The tunnel was driven through shale, sandstone beds and cannel, about 4,700 tons of debris being removed from the pit in this week



HYDRO-ELECTRIC POWER STATION.—This power station in Australia has a staff of one. It is operated by pushbutton from Sydney 48 miles away. Under a comprehensive contract the English Electric Company Limited supplied a 69,000 hp water turbine and 50,000 kW generator, step-up transformer and switchgear, and auxiliary transformer and switchgear and control gear

in addition to an output of 7,213 tons of coal. The drivage was carried out by six face men per shift, using six Holman (Silver Three) drilling machines equipped with Padley and Venables 10 ft drills and tungsten carbide tipped bits.

The broken ground at the face was removed by a Distington-Goodman 50 B. tunneller. This 12-ton, 70 hp machine has been in service at Bank Hall colliery since June, 1957. The spoil was then loaded into 4½-ton mine cars, which are also of Distington Engineering Company's manufacture.

Italian Steel Plant

One of the largest steel companies in Italy, Cornigliano of Genoa, have launched an expansion programme which will result in a yearly production of over two million tons of steel ingots and will double the present capacity of the plant. The project, which will take two years to complete, began with the installation of a new blast furnace with a capacity of 1500 tons per day: the increased productivity at Cornigliano is now being further expanded with the erection of a 46 in. slabbing mill which is one of the largest in the world. It is powered by twin 7000 hp engines and has been designed by the Mesta Machine Company of Pittsburgh and has been entirely constructed in Italy by INNOCENTI of Milan. All the electrical equipment has been supplied by the Italian Marelli Company to Westinghouse specifications.

INNOCENTI are building three more blooming and slabbing mills of similar dimensions to that now in operation at Genoa and a 66 in. continuous hot strip rolling mill to Mesta design.

Australia's Largest a.c. Mine-winder

The largest a.c. winder so far commissioned in Australia, and the first to be fitted with power-operated brakes, has recently been installed by Australian Electrical Industries Pty. Limited at a mine near Newcastle, New South Wales.

The winder, driven by a 1,100 hp, 570 rpm, 6,600-volt, 50-cycle slip-ring induction motor, is designed to raise 300 tons of coal an hour from a depth of 720 ft. Speed variation and direction of winding are governed by a liquid controller and an air-break reversing contactor. A single-reduction gearbox connects the motor to the winding drums, the maximum speed of which is 68 rpm. In addition to the mechanical brakes, the driver has an electrical braking system which incorporates (i) regenerative braking, (ii) reverse current braking, and (iii) dynamic braking.

The main electrical equipment for the winder was manufactured by the A.E.I. Heavy Plant Division, the auxiliary equipment by Australian Electrical Industries at their Sydney Works, and the mechanical equipment by Marfleet and Weight, Melbourne, to the design of Markham & Co. Limited, Chesterfield.

Design and Application Factors for Retaining Rings

Retaining rings may often be used to simplify design and production, and speed assembly. Various types of ring offer a wide choice to accommodate different loadings to be carried. This article discusses the main types of groove-fitting rings, their properties and applications

THE most common forms of retaining rings are those designed to locate and seat in grooves on a spindle, shaft or housing, which besides providing precise positioning of components can also accommodate axial or thrust loads. By the proper application of retaining rings, both manufacturing and assembly time can often be reduced, as well as simplifying and speeding dismantling for maintenance, etc.

From the basic types of groove-fitting retaining rings, numerous other types have been developed with varying geometry offering specific advantages in particular applications. In addition there are numerous forms of self-locking rings which normally have a one-way (but sometimes two-way) locking action on a plain spindle, spigot or stud. Their chief application is where speed and simplification of assembly is important and where the complete assembly is not stressed axially to any great extent, as in typical fastening applications. The use of such self-locking rings may also simplify production by permitting the use of plain instead of threaded studs, the locking ring performing the duty of a nut.

The two basic types of groove-located retaining rings are shown in Fig. 1, the external ring being designed to fit around a shaft or spindle and the internal ring designed to fit a groove in a housing. The principal difference is in the shape and location of the lugs to permit the ring, once installed, to assume constant circularity and pressure against the bottom of its locating groove. On large diameter external rings, too, the lugs may be specially proportioned to maintain ring balance under high speeds of rotation.

A variation on this basic design employs "inverted" construction where the lugs are mounted in the contra manner, i.e. an external ring looks like an internal ring at first sight, and vice versa—see Fig. 2. With inverted rings the lugs actually engage the bottom of the grooves.

The specific advantage offered by inverted rings is that they can be fitted with smaller clearance dimensions. They also present a higher uniform shoulder when assembled, although they are normally rated a little lower for carrying thrust loads. Like the two basic types, however, they are intended for fitting and dismantling in an axial direction.

Where the component geometry is such that it is more convenient or even strictly necessary, to assemble the retaining ring in a radial direction by springing in position over a shaft, various alternative designs are produced. A selection of typical ring forms are drawn in Fig. 3. The E-ring is the most common, so called because of the configuration of its three lugs. Actual geometry may vary, the ring width being increased to provide a stronger section. The actual bearing length, however, still remains the bearing length of the three lugs inserted in the shaft groove and hence the thrust capacity is lower than with normal rings.

The C-ring or crescent ring is another alternative, normally produced with a tapered section and intended to secure against involuntary movement, vibration or impact rather than take constant thrust load although the effective bearing length is quite high. Thrust load rating is, in fact, about half that of the basic type of ring. Some typical comparative figures are shown in Table I.

Another form of radially mounted retaining ring which has come into use is the two-part interlocking ring, Fig. 3, which consists of two identical halves which lock together by means of prongs at the free ends, when mounted. Besides being rated for quite high thrust loads, this design is statically balanced and thus particularly suited for duty on high speed shafts.

Another family of retaining rings is that designed to

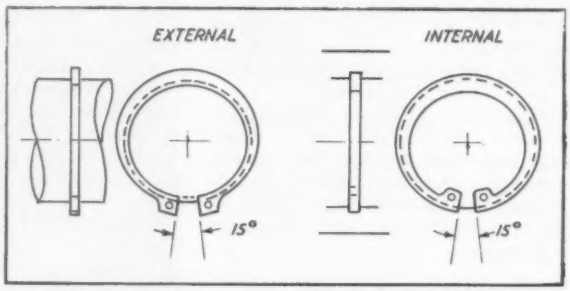


Fig. 1.—Basic retaining rings—external for shafts, internal for housings

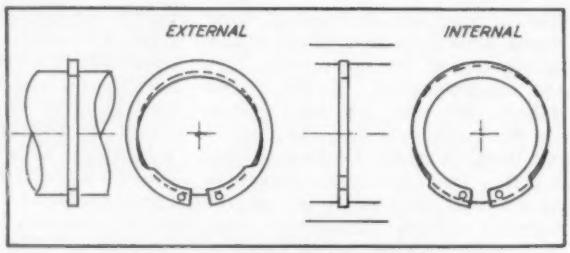


Fig. 2.—Inverted retaining rings for closer clearances

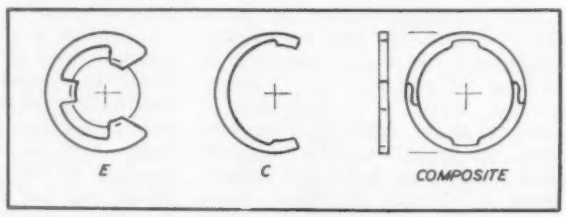


Fig. 3.—Typical forms of radially fitted retaining rings

take up end play. The ring forms already described are followed with either a taper section, or bowed in side elevation. Bevelled rings take up end-play in a positive, rigid manner whilst bowed rings take up end-play by spring action.

Bevelled rings are restricted to the basic external and internal types, see Fig. 4. Both the C- and E-rings are rendered in bowed form, and also the two basic types again in bowed form, Fig. 5. With the basic rings, therefore, the designer has the choice of selecting rigid or resilient take-up of end-play according to whether he selects a bevelled or bowed ring.

All forms of groove-locating retaining rings are commonly made from carbon spring steel, although rings can be made in almost any other material if specifically called for. On a standard production basis rings may be expected to be available in beryllium copper, phosphor bronze, stainless steel, and some in aluminium. The variety and sizes available in different materials will vary with different manufacturers and of these alternative materials possibly only beryllium copper could be classed as commonplace.

Design factors involved are straightforward. Ring manufacturers specify all rings according to diameter size, i.e. a ring specified for a particular shaft or housing diameter is correctly proportioned for locking on that diameter, consistent with recommended groove dimensions. Load figures are taken care of by quoting allowable thrust load for each size of ring, which figure is normally based on a safety factor of four. In the case of bowed rings the pressure required to flatten the ring is also usually quoted. Groove diameter and width are also specified, together with permissible tolerances, and also groove depth required. Load figures assume that this recommended groove geometry is followed.

For more specific analysis, or to investigate the effect of different ring materials, etc., load calculations may be carried out on the following basis:

max. thrust $= \pi t S_s D$ (in shear)
$= \pi h S_t D$ (in tension)

The ring itself is in shear, hence the shear formula applies. S_s is then the shear strength of the ring material, when

max. thrust $= \pi t S_s D$

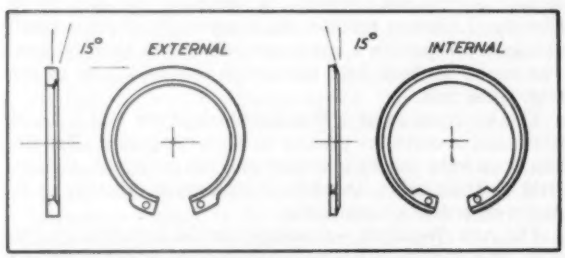


Fig. 4.—Bevelled retaining rings (basic type only)

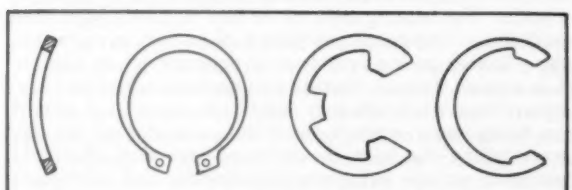


Fig. 5.—Bowed retaining rings—basis, E and C

where t = ring thickness, in.
D = shaft or housing diameter, in.

Allowing the usual safety factor of 4
max. permissible thrust $= \pi t S_s D/4$ 1

The groove is subject to failure under tensional loading, hence the tension formula applies

max. thrust $= \pi h S_t D$
where h = groove depth, in.
S_t = tensile yield stress of shaft or housing material
D = shaft or housing diameter, in.

Again, with the same safety factor
max. permissible thrust $= \pi h S_t D/4$ 2

For maximum economy of design, maximum allowable load calculated by both formulae should agree. Alternatively it can be specifically calculated for the retaining ring to fail before the shaft or housing, which would normally be desirable under such extreme conditions of loading on the basis that the ring is more easily replaced.

Formulae 1 and 2 can also be used for calculation of groove diameter and groove depth to suit non-standard applications of available rings, and to check the effect of different groove proportions, different ring materials and so on. They can also be used as a basis for load calculations with bowed rings, applying the load factor appropriate as given in Table I. The effects of dynamic and impact loads can also be estimated on a similar

Table I.—TYPICAL PROPERTIES OF STANDARD RETAINING RINGS (IN CARBON SPRING STEEL)

Type	Diameter Size	Thickness	Max. Permissible Thrust	Thrust to Flatten	Load Correction Factor	
					Ring	Groove
	in.	in.	lb.	lb.		
Basic, External	¼	0·010	110	—	1·0	1·0
,, ,,	½	0·025	590	—	,,	,,
,, ,,	¾	0·035	1,650	—	,,	,,
,, ,,	1	0·042	4,950	—	,,	,,
,, ,,	5	0·109	64,200	—	,,	,,
Basic, Internal	¼	0·015	350	—	,,	,,
,, ,,	¾	0·035	1,650	—	,,	,,
,, ,,	1	0·042	4,950	—	,,	,,
,, ,,	5	0·109	64,200	—	,,	,,
Inverted, External	¼	0·035	1,100	—	0·66	0·33
,, ,,	1	0·042	3,300	—	,,	,,
,, ,,	4	0·109	34,300	—	,,	,,
Inverted, Internal	¾	0·035	1,650	—	,,	,,
,, ,,	1	0·042	3,300	—	,,	,,
,, ,,	4	0·109	34,300	—	,,	,,
External, Bowed	¼	0·025	590	120	1·0	0·8
,, ,,	¾	0·035	1,800	84	,,	,,
,, ,,	1	0·042	4,950	35	,,	,,
Internal, Bowed	¼	0·015	330	28	,,	,,
,, ,,	¾	0·035	1,650	120	,,	,,
,, ,,	1	0·042	4,950	45	,,	,,
External, Bevelled	1	0·042	4,950	—	1·0	0·5
,, ,,	2	0·062	14,600	—	,,	,,
,, ,,	5	0·109	64,200	—	,,	,,
Internal, Bevelled	1	0·042	4,950	—	,,	,,
,, ,,	2	0·062	14,600	—	,,	,,
,, ,,	5	0·109	64,200	—	,,	,,
E-Ring	¼	0·025	255	—	0·33	0·66
,,	¾	0·042	1,110	—	,,	,,
,,	1	0·050	2,750	—	,,	,,
E-Ring, Bowed	¼	0·025	255	45	,,	,,
,, ,,	¾	0·042	1,110	120	,,	,,
,, ,,	1	0·050	2,750	60	,,	,,
Crescent and Bowed Crescent	⅛	0·015	70	—	0·5	0·5
	¼	0·025	290	—	,,	,,
,, ,,	¾	0·035	530	—	,,	,,
,,	1	0·042	2,480	—	,,	,,
Interlocking	¼	0·035	2,100	—	0·75	0·75
,,	1	0·050	5,850	—	,,	,,
,,	2	0·078	18,500	—	,,	,,
,,	3	0·093	33,000	—	,,	,,

Table II.—CORRECTION FACTORS FOR IMPACT LOADING (MAX. PERMISSIBLE)

	Static Max. Permissable load *multiplied by*
Ring	0·5 × ring thickness (inches)
Groove	0·5 × groove depth (inches)

basis. Suggested factors for use are given in Table II. These are applied to the maximum permissible load as calculated by either formula 1 or formula 2 to arrive at the maximum permissible load under dynamic conditions.

One further aspect of design which may appear worth investigating is limiting speeds. Since most forms of retaining rings are relatively light, this is not normally likely to be critical except in very large diameter sizes. Any limitations, too, will apply only to external rings used on shafts, internal rings not normally being affected by rotation—although either type may be sprung out of the groove under very adverse operating conditions.

As a generalization, on shaft diameters of $\frac{1}{2}$ in. or smaller, none of the standard forms of rings is likely to exhibit any limitations, except possibly E-rings above 20,000 rpm. At 1 in. shaft dia size, E-rings would not normally be rated for speeds much above 5,000 rpm, and the basic types of rings above 20,000 rpm. With all larger shafts, where basic type rings are normally employed, an approximate estimate for safe maximum rotational speed can be obtained from

$$\text{max. safe rpm} = 20{,}000/\text{shaft dia (in.)}$$

New Wickman-Scrivener Centreless Grinder

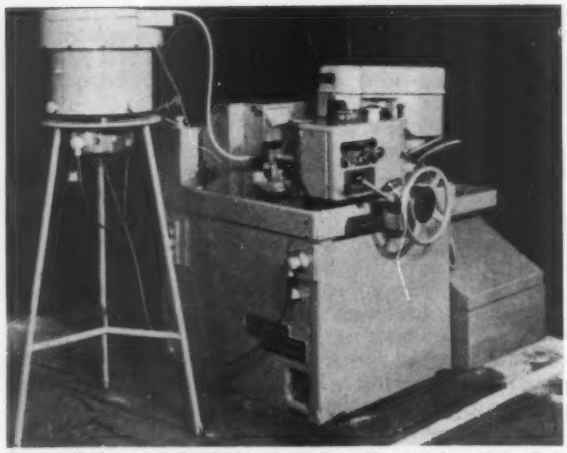
The latest Scrivener small precision centreless grinding machine, the Wickman-Scrivener No. 0, has a nominal capacity from 0·020 in. to $\frac{5}{8}$ in. dia. It embodies a number of advanced features to provide exceptional accuracy coupled with versatility and convenience of operation.

Optionally available for the first time on machines of this size is an anti-friction main slide consisting of Dexter ball-slides especially suitable for use in conjunction with the Wickman-Scrivener Microsizer which is also available as an extra. The microsizer unit conveniently provides push-button incremental advance of the control head by tenths up to 0·0005 in., equally useful when setting up and on long runs to close limits with unskilled labour. In the latter case, it is only necessary for the operator, on gauging the work and finding it to be growing above the upper tolerance limit, to press the button and so advance the control wheel a predetermined amount to compensate. The same equipment likewise forms the basis of fully-automatic size control from built-in gauging units when necessary.

An exclusive feature is the provision as standard of separate hydraulically-operated power-truing attachments for each wheel, enabling any desired profile (straight, taper, or form) to be obtained by fitting the necessary former plate. On the grinding wheel side, the attachment is ball-bearing-mounted to enable steeper slopes than normal to be climbed with ease, and to permit the more accurate following of extreme forms. On the control-wheel side, the attachment is fitted to the fixed (not the tilting) member of the control-head slide, so that truing slide and diamond always move in a horizontal plane substantially parallel to the grinding wheel.

Unique on centreless grinding machines of this size, is the provision of stepless variation of the traverse rate of both diamonds, this as well as the direction of traverse being under centralized hydraulic control by a single "Telecontrol" valve conveniently situated at the operator's left hand.

A time-saving feature is the incorporation of a work-rest coupling by which the rest can instantly be connected with, or disconnected from, the control-head slide at will.



Dexter ball slides can be had in this new small precision centreless grinder. Each wheel has separate power truing

This greatly facilitates adjustment of the rest from time to time to follow up grinding-wheel wear.

It is possible for the hand-operated machine to be converted to controlled-cycle operation. The equipment consists of an auto in-feed cam slide attached to the upper bed of the machine, and a separate self-contained power unit console connected to the machine by hydraulic hoses and plug-in flexible electrical connections. Amongst the advantages of controlled-cycle operation are the complete elimination of variations in the grinding cycle time or any of its elements, the virtual elimination of operator fatigue inseparable from the continuous manual operation of a plunge-feed hand lever, and a wider wheel opening of about 1 in. in place of 0·06 in. possible with hand operation. Finally, the unit also lends itself particularly to the application of hopper or other forms of feeder with an intermediate loading mechanism to make the machine entirely automatic in operation.

The machine is made by Arthur Scrivener Limited, Tyburn Road, Birmingham 24.

Repair Kit for Conveyor Belts

A new machine developed by Stenor Limited, Kew Foot Road, Richmond, Surrey, a member of the Firth Cleveland Group, reduces the time required for a small vulcanized repair in a conveyor belt to less than 30 min. The repair is flush with the cover and as strong as the rest of the belt.

The kit consists of a Weldbelt vulcanizer and a set of tools and accessories packed in a carrying case. Repairs can be carried out by one man and the system is particularly suitable when the belt is operating outside, or in damp or arduous conditions.

The new Weldbelt vulcanizer can be handled by one man, and may be either unsupported for attachment to a bench or on a movable stand or with fittings for fixing to a girder. The heating units of the new Weldbelt have been re-designed and instead of being a 10 in. × 6 in. rectangle, the effective curing area is now enlarged to an 8 in. × 8 in. square. To each heating unit has been added an 11 in. square base plate which is important when large repairs are being made: when a repair has to be carried through by 'stepping' the joint, the extended base plate effectively prevents 'set-up' occurring in adjacent and previously cured areas. Edging bars allow repairs to be carried out to the edge of the belt without 'spewing'.

A full three-dimensional description of the error of form of cylindrical components is given by the new Formicator measuring instrument

Instrument for Measuring Roundness, Parallelism and Straightness of Cylindrical Components

A new instrument which not only measures roundness circumferentially, but with the same stylus also measures straightness and parallelism (vertically), and by so doing provides a full three-dimensional description of the error of form of cylindrical components, is made by Messrs. Hommel of Germany, who are represented by Rubert & Co. Limited, of Cheadle, Cheshire. Another innovation is the automatic centring.

The instrument measures up to a maximum diameter of 150 mm (6 in.), and vertical height of 200 mm (8 in.), with a maximum magnification of error of form × 10,000. The equipment is in four parts consisting of the mechanical testing apparatus, the graph recorder, the control equipment and the viewing equipment.

The mechanical testing apparatus consists of a high precision turn-table with centring clamps which provide a mechanical preliminary centring. There is no more adjustment necessary as the high precision centring is completed automatically.

The contours of the cylindrical specimens are traced by an electrical system fitted to a slide which moves on a vertical column. This column is finished to a high degree of accuracy, thereby providing a reliable reference line. The column can be moved horizontally in order to provide a rough adjustment to the diameter of the specimen. The actual fine adjustment is also performed automatically.

The tracer arms are easily exchangeable to provide for the tracing of inside and outside diameters. A further important feature is the protection of the tracer system against damage whilst being moved towards the specimen.

The smallest bore that can be measured is 3 mm (0·120 in.) dia. The turn-table has two speeds, i.e. 5 and 10 rpm.

The recording instrument can be seen on the left-hand table in the illustration, and has two parts, one a polar recorder for recording errors of roundness, with a radial magnification up to 10,000, and another recorder with a graph paper moving horizontally (as in surface roughness measuring instruments) for measuring parallelism and vertical error of form. Both the radial and linear recorders are electrically connected to the turn-table and the vertical movements of the tracer system respectively, whereby the vertical movement can be recorded in ratios of 1:1, 1:2, or 2:1.

The measuring range can be selected with the respective magnification such as:

Measuring range	*Magnification*
±200μ	100×
100	200
40	500
20	1000
10	2000
4	5000
2	10000

The control equipment can be seen in the illustration on the lower shelf of the left-hand table, and provides fully automatic centring of the specimen so that considerable time is saved and the actual centring process can be observed on the viewing instrument.

The viewing equipment, shown in the illustration next to the graph recorder, consists of a cathode-ray tube on the screen of which appears the cross section of the specimen according to the magnification selected. The automatic centring can be observed on the screen and provides comfortable checking of the centring performance. After the centring, which takes only a few seconds, the error of form can be clearly seen, without the use of the graph recorder. The recording on the polar diagram, therefore, in most cases becomes unnecessary and will only be carried out when a permanent record is required.

The price of the Formicator, as the instrument is known is approximately £3,500.

Miniature Construction System

A self-contained set of selected standard elements which can be assembled into models of various kinds such as prototypes of machinery and other equipment or for experimental or educational work is called "Weyco Fac". Machines of various kinds for production use can be made of it and it can save time and money where small, special-purpose machines are required.

The main principle consists of round rods and beams, assembled into a framework and clamped together. There are no limitations on the size of supporting structures. The small components may be mounted at any required point along the framework members. The framework can be made to support heavy loads.

An important feature of the system is a wide assortment of current machine units, including power transmitting parts such as gears, shafting and bearings. When a model is no longer required, it can be dismantled and the parts used again and again for other purposes.

For applications where relatively large clamps would be detrimental to general appearance, a complete line of small threaded parts (male and female) are included in the system. Among these are various bushes, sleeves, rings, eye-bolts, studs, collars, rods with threaded ends, etc., made possible by the difference in diameter between rods and screws.

There are two sizes: X1, costing £49 10s.; and X2 (containing nearly 5,000 parts), which costs £86. Each is supplied with an instruction manual and is contained in a stout wooden case. Any parts in the system may be purchased separately, without first purchasing an X1 or X2. The makers are Weyco (Equipment) Limited, 18/20 Dames Road, London E7.

Choosing and Fitting Porous Metal Bearings

In order to obtain optimum performance from pre-lubricated sintered metal bearings, it is essential that a correct choice be made for the function envisaged and that the method of fitting—and the fit—shall be such as to assure the correct final size. Sizing after fitting, using a burnishing tool, can be advantageous where the highest degree of precision is demanded.

POROUS metal bearings are greatly superior to solid bearing shells when service conditions preclude regular replenishment of lubricant, and thus find wide application in office machinery, domestic appliances and the like. Although the ability to operate for long periods without attention is the most obvious characteristic of porous bearings, and is usually the deciding factor in their adoption, they offer other substantial advantages. The installed cost of a porous bearing is nearly always less than that of a conventional solid bearing and, provided that the bearing is correctly chosen for its service and is properly fitted, the actual bearing characteristics compare very favourably with those of solid ones.

This is particularly the case with light loads and high speeds, for although the starting torque is appreciably higher in the case of the porous bearing, the coefficient of friction under running conditions is consistently lower than that of the solid equivalent. The accepted parameter is (viscosity × superficial velocity/load), seen plotted against friction in Fig. 1. From this it is clear that the superiority of the porous bearing becomes the more marked as the velocity increases or the load decreases, since either condition yields larger values along the horizontal of the chart. This highly favourable characteristic is attributable to the fact that, the surface being fed by capillarity, a porous bearing operates always under conditions of thin-film lubrication.

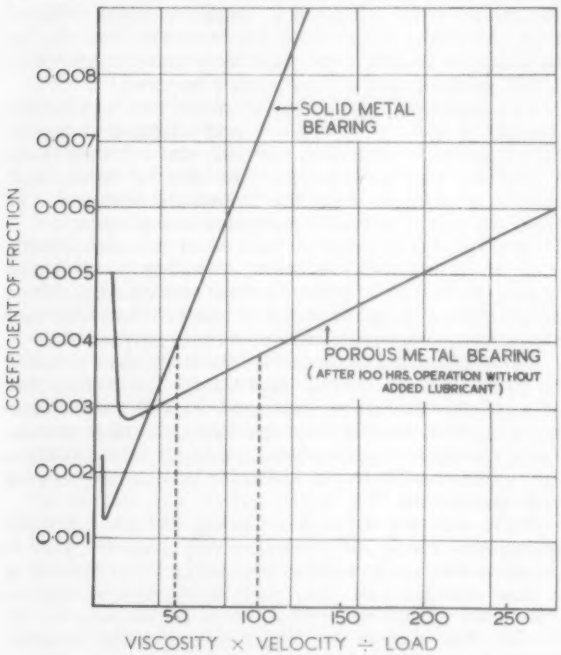


Fig. 1.—Friction characteristics for porous metal bearings

In the case of solid bearings, it is sound engineering practice to limit the horizontal parameter to $\alpha = 50$; i.e., to a limiting coefficient of friction in the region of 0·004. It has been found satisfactory to set the corresponding value for porous bearings at $\alpha = 100$. Taking as standard a porous bearing which has run continuously for 100 hr without added lubrication, the corresponding coefficient of friction is still lower than that for the solid bearing, as the broken lines in Fig. 1 indicate. The product ρV (load × velocity) should preferably fall within a maximum of 50,000, ρ being expressed as pounds per sq in. and—superficial—velocity V as ft per min. Since in most applications V is already determined, the area of the bearing surface must be chosen to bring ρV within the limit stated.

With these requirements properly met, porous bearings can be relied upon to give satisfactory service if correctly fitted. It is essential, however, that both the fit of the bearing in its housing, and the clearance allowed for the running fit of the shaft, shall be properly determined. Whenever possible, shaft sizes should be chosen to allow the use of standard size bearings; under light loads the required clearances are a little less than for solid bearings and should lie within the limits of Fig. 2. As sintered bearings have relatively low compression

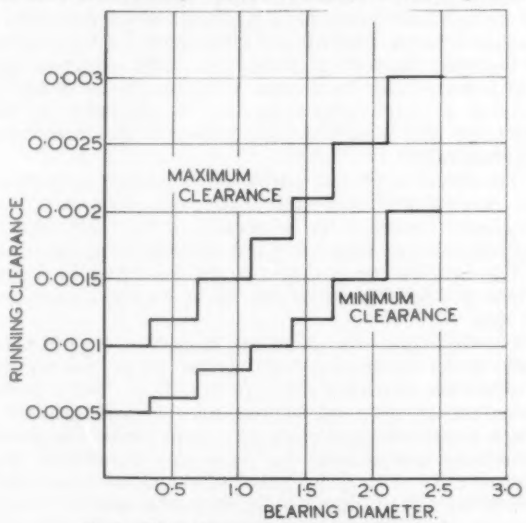


Fig. 2.—Fitting clearances for porous metal bearings

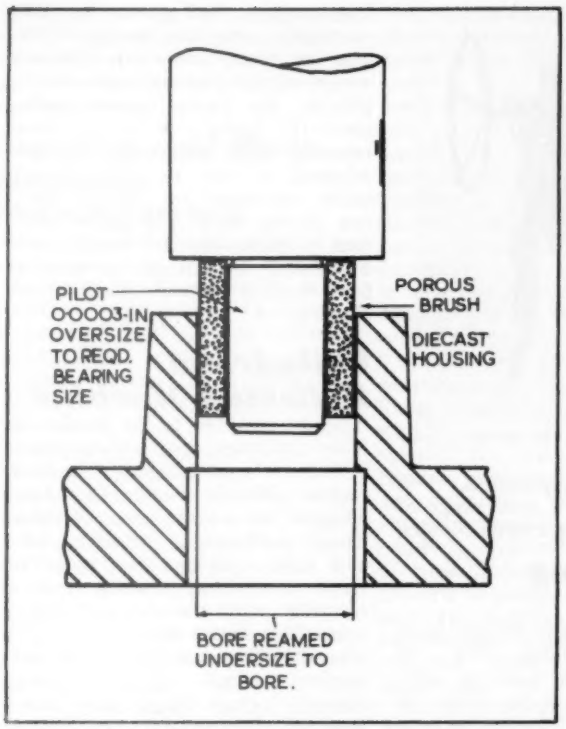


Fig. 3.—Mandrel for fitting porous metal bearings

strength, the internal diameter must be supported by a mandrel during insertion into the housing.

The mandrel is accurately ground and lapped to a diameter 0·0003 in. larger than the required hole size (Fig. 3), which in turn should be 0·005 in. smaller than the i.d. of the bearing *before assembly*. This practice, adopted by large users of porous bearings, assures correct bearing size when the bush is pressed into its housing with the correct interference fit. Preferred limits for press fits are given in Table I. Nevertheless, where the fit of the assembly is highly critical, it is desirable to size the bore with a burnishing tool. This may be a simple ball-ended punch if the bore is to be opened up by only two or three ten-thousandths of an inch; otherwise, a broach-type, multiple-land burnisher is to be preferred. For large-diameter bearings, spiral burnishers similar to a spiral reamer, but with no cut, are preferred by some users. As a general rule, the maximum increase in size achieved by burnishing should not exceed 0·001 in. per in. of internal diameter.

Table 1.—INTERFERENCE FITS FOR POROUS METAL BEARINGS

Nominal Housing Diameter	Limits in Ferrous Metal	Limits in Non-ferrous Metal
Up to ¼ in.	H—0·0002 L—0·0010	H—0·0002 L—0·0020
¼ in. to ½ in.	H—0·0005 L—0·0015	H—0·0005 L—0·0030
½ in. to ¾ in.	H—0·0012 L—0·0020	H—0·0012 L—0·0035
¾ in. to 1 in.	H—0·0015 L—0·0027	H—0·0015 L—0·0040
1 in. to 1½ in.	H—0·0020 L—0·0030	H—0·0020 L—0·0045
1½ in. to 1½ in.	H—0·0020 L—0·0035	H—0·0020 L—0·0050
1½ in. to 1¾ in.	H—0·0025 L—0·0040	H—0·0025 L—0·0055
1¾ in. to 2 in.	H—0·0030 L—0·0045	H—0·0030 L—0·0060

While it is not good practice to modify stock bearings by drilling, turning or grinding, this may occasionally prove necessary in prototype work. As all such machining operations tend to smear the surface and impair porosity, it is difficult to produce special bearings of this sort with characteristics equal to those of pressed bearings. The most satisfactory results are obtained by first degreasing the component and then re-working it as desired, leaving both bore and external diameter about 0·002 in. oversize. The bearing is next immersed in a 50/50 solution of nitric acid and water for 50 to 60 sec (at room temperature) and is immediately washed thoroughly in cold running water. After thorough drying, it is re-lubricated by immersion in the appropriate lubricant, heated to about 180° F, for fifteen minutes. The bush is now pressed into its housing and will be found very slightly undersize; it may be sized by burnishing as already described. It is highly important, when lubricating re-worked or special bushes, to use the manufacturers' recommended oil. Because of the extensive surface exposed by a bronze bearing to the oil, and the known catalytic properties of copper, many oils oxidize readily when the bearing temperature rises. Only oils with high resistance to oxidation are accordingly satisfactory in porous metal bearings. This is not, of course, the only special requirement for such lubricants; as they operate under "thin film" conditions, a high film strength is essential. It is also desirable that the absolute viscosity gradient over the envisaged range of operating temperatures be as shallow as possible, or the more or less straight-line relationships of Fig. 1 cease to hold.

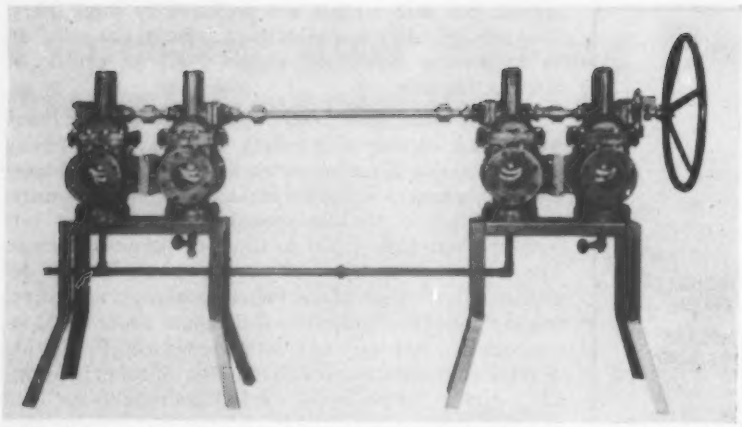
Fire Chemical Hose

Recently developed for heavy duty, high pressure service is the Goodyear Fire Chemical Hose (Goodyear Style 223), which is specially designed for wash-down duties and fire protection, including chemical foam, on tankers.

It is also eminently suitable for the prevention, detection and control of fires in refineries, tank farms, oil jetties, mines, mills and factories, The hose, manufactured in 50 ft or 60 ft lengths, has a smooth 2½ in. bore which ensures maximum flow. Flexible and light in weight, it has a guaranteed test pressure, on delivery of 400 psi.

The tube consists of a smooth, seamless and non-porous synthetic rubber which has excellent resistance to ageing, whilst the reinforcement is of a braided, high tensile, synthetic fibre yarn. The synthetic rubber cover gives age and abrasion resistance in addition to withstanding the effects of oils, greased and dilute acids.

Although the hose may be used with several types of fittings, one coupling in particular—the internal expansion ring type, with pin-lug—is supplied and recommended. This is a permanent streamlined coupling available with fire hose threads.



Eight wedge gates in four valves enable plant changeover to be made quite simply by the operation of one handwheel

Two-in-one Changeover Valve

A new Changeover-Control-Valve designed for use with oil coolers in a turbo-generator provides two opening and closing actions with one movement of the control wheel. The valve has been designed and manufactured by R. Blackett Charlton and Company Limited, of Manors Works, Newcastle upon Tyne, following a request by C. A. Parsons & Co. Limited. The problem referred particularly to the turbo-generator installed by Parsons at Oji in Nigeria.

The requirement was for a valve which would ensure beyond doubt that the second stand-by oil cooler would come into operation before the one in service was shut off. This means that there can be no risk of damage to the turbo-generator by both coolers inadvertently being shut off at the same time.

The Charlton changeover-control-valve (Patent applied for) has eight wedge gates in four valves all operated by one control wheel and shaft, actuating a rack and pinion in each valve. As the four wedges controlling the supply of water and oil to the first cooler are being closed, the four opposite wedges are simultaneously opening. There is no time lag in the operation, and, therefore, no danger to the turbo-generator. A special spring adjustment mechanism is incorporated in each valve to ensure that the wedges open and close fully.

The body of the valves for both oil and water are all cast iron while their wedges on the water side are of stainless steel, and gunmetal on the oil side.

Although the valve was designed for a particular application, it is suitable for use in a wide range of operations involving cooling circuits.

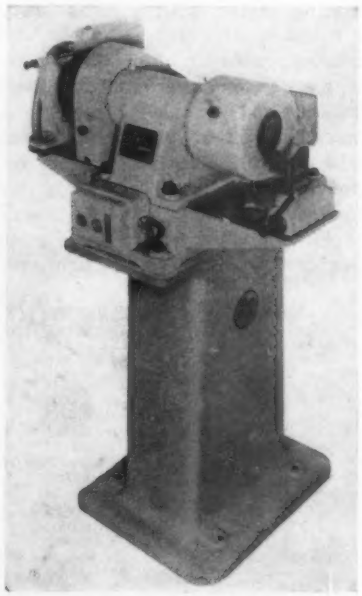
Plate Lifting Clamps

The double-cam plate lifting clamp originated by Interlas N.V., of Holland, are much used by shipbuilding and engineering firms on the Continent, They have now been made available in the United Kingdom through Interlas Limited, 9 Church Street, Ampthill, Bedford. There are seven different sizes in the full range to accommodate loads of 1½ tons maximum to 20 tons maximum, and plate thicknesses of ¾ in. maximum to 3 in. maximum. The clamps are ingeniously designed to lift plates or fabricated plate sections without any danger of the load slipping. The greater the pull, the tighter the cam operated jaws grip the plate, and even when the weight of the plate is taken on the ground, the clamp cannot loosen until the locking lever has been released. When the clamp has been released, it can be pulled away easily, as there are rollers which run on the plate. The grip is such that a plate can be raised from horizontal to vertical or lowered from vertical to horizontal without slipping.

The Interlas plate clamp has a double-cam action and also a locking device. Riding rollers ensure its easy withdrawal

Cylindrical Polishing Machine

A recent addition to the Rudkin & Riley (Leicester) range of equipment is their hand-polishing machine (model 2006/3) which has been designed for a wide range of cylindrical workpieces, including wire and tube drawing dies, etc. The standard machine, which is supplied complete with electrics to form a neat and compact unit, is fitted with an adjustable handrest and aluminium chuck guard. Design features include large taper roller bearings, convenient lubricating points, and overall sturdiness to give long and trouble-free service. Chuck sizes up to 7½ in. can be fitted and the speeds available are 2,400 and 3,150 rpm (2,850 rpm motor) and 1,200 and 1,575 rpm



Designed to deal with cylindrical work pieces from wire upwards, the new Rudkin & Riley polishing machine is self-contained and suitable for either bench or floor mounting

(1,425 rpm motor). Extra equipment, which is optional, comprises electro-magnetic brake, low voltage lighting, and a cast stand as an alternative to bench mounting.

Forging and Drop Hammer Developments

Three new developments relating to forging and drop forging hammers have been introduced by B. & S. Massey Limited, Openshaw, Manchester. They are new footlever guards for pneumatic power hammers, nylon lifting belts for friction drop hammers and friction band linings and hold-up band linings for drop hammers.

During the many years B. & S. Massey Limited have been supplying pneumatic power hammers, they have occasionally heard of accidents that have been brought about by the inadvertent operation of the footlever, or by a workpiece falling from the lower pallet. In an attempt to prevent such accidents various guards were made but were not completely successful as they either impeded the operator's access to the pallets or prevented complete freedom of the foot when operating the footlever.

The guard shown in Fig. 1 overcomes these difficulties. It has been in practical use in the smithy of B. & S. Massey Limited for a number of months and as it has proved entirely satisfactory to the operators it is now being produced commercially.

Prior to nylon becoming a commercial proposition, the use of woven hair lifting belts was general practice in the drop forging industry. For a number of years now, B. & S. Massey Limited have been subjecting nylon lifting belts to severe drop hammer tests, under actual forge conditions. The earlier type of nylon belt proved to have too great a stretch, but the manufacturers have now devised a belt (Fig. 2) that is superior in every way to the woven hair belt originally used. Some users have reported that this nylon belting has lasted for more than five years. It is now being marketed by B. & S. Massey Limited who advise its use on their drop hammers.

In the early post war years, the manufacturers of friction brake linings began to use new materials which made their product less suitable for friction and hold-up bands, particularly those of the self-contained and Marathon hammers where the drum diameter is relatively small. Following a number of band failures, B. & S. Massey Limited instituted an investigation into the matter, and now offer linings (Fig. 3) which have passed stringent tests under working conditions.

High-Temperature Tunnel Kilns

An extension to their range of small, special-purpose, high-temperature tunnel kilns for the electronics, ceramics and other industries, has been introduced by the Allied Engineering Division of Ferro Enamels Limited, Wombourn, Wolverhampton. These kilns are in a range of sizes from 15 ft to 60 ft. and in all temperature ranges from 800° C to 1400° C, and are of the sliding-plate tunnel type. The range is supplementary to the small special-purpose, car-type tunnel kilns now available in the temperature range 800° C to 1600° C. Both types are electrically fired.

The sliding-plate type is heated by elements placed under and over the charge, which is particularly suitable for charges of low setting height where stacking is to be avoided; the car type of furnace is heated by elements radiating at the side of and underneath the charge and has its particular application in relatively heavy loads or for larger outputs where the charge can be stacked several pieces higher.

Both types are prefabricated for easy sectional assembly on the job and with their range of temperature application and low time cycle of operation are suitable for a wide variety of uses.

Personal Safety Block

The Sala personal safety block for the security of operators working in high places contains 16 ft of steel wire rope which is spring loaded and controlled by a braking device. It can be quickly fixed anywhere and has a locked hook for simple attachment to the safety belt. The worker has completely free movement and the rope is always taut but in the event of a fall the brake operates and the man is gently brought to a stop within 12 in. and supported. The block is supplied by Neldco Processes Limited, Crossway House, Bracknell, Berkshire.

Fig. 1.—Footlever guard for Massey pneumatic power hammers

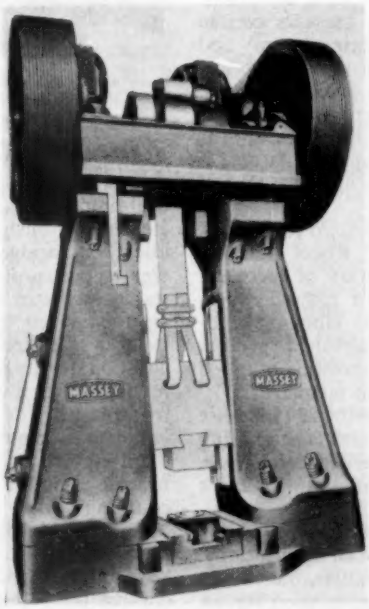


Fig. 2.—Friction drop hammers with nylon lifting belts

Fig. 3.—Friction linings for drop hammers

Miniature a.c. Motor

The new Size 11 a.c. hysteresis motor marketed by Smiths Aviation Division has a mechanical output of 8 watts for an outside diameter of $1\frac{1}{16}$ in. It will start under full load, has completely synchronous operation, a short (1·58 in.) body length, and can be used on either 200 V or 115 V 3-phase 400 cps supplies. A 50 cps version is under development.

Possible applications include blowers in electronic equipment, drive for programme units in missiles and computers, tape mechanism drives on, for example, airborne tape recorders, and speed servos.

The 3-phase 4-pole motor has the performance given in the first column below when "star" connected. It can also be connected in "delta" with a line to line voltage of 115. A 2-phase 6-pole version is also available with the performance shown in the second column below.

		3-phase 4 pole	*2-phase 6 pole*
Electrical Data			
Voltage at 400 c/s	V	200	115
Stall current	mA	145	132
No load current	mA	98	123
Max. sync. torque current	mA	102	115
Total stall input	W	26	12
Total no load input	W	7·0	7·2
Max. sync. torque input	W	15	9·2
Mechanical Data			
Mechanical output	W	8	3
Synchronous speed	rpm	12,000	8000
Max. sync. torque	gm.cm	60	35
Stall torque	gm.cm	60	35
Efficiency	%	50	35
Weight	oz.	$4\frac{1}{4}$	$4\frac{1}{4}$
Temp. rise	°C	50	50
Moment of inertia	gm.cm²	2·9	2·7

Lubricating Textile Machinery

Jacquard, like some other machinery, presents certain lubrication problems inherent in their design and function. They are usually sited so that regular lubrication is not physically easy and is thus often neglected. Dust and grit accumulate on oily, greasy wires and mechanisms, causing abrasion; thus, paradoxically, as more ordinary lubricant than is really necessary is applied, the greater the risk of abrasion and also that of staining yarn.

The success of certain Rocol molybdenized lubricants, manufactured by Rocol Limited, Rocol House, Swillington, near Leeds, in the lubrication of Jacquard machinery has led to one well-known manufacturer, Samuel Dracup & Sons Limited, Great Horton, Bradford, to depart from their long-established general principle of refusing to recommend specific, branded lubricants for the lubrication of Dracup jacquards.

Rocol molybdenized lubricants provide long-life lubrication with a minimum of lubricant, thus promoting a near dry system of lubrication, high resistance to wear, saving of time and labour and the elimination of thick films of lubricant.

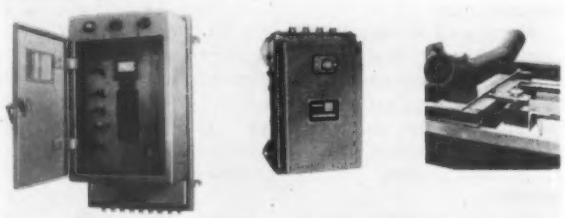
Rocol Molypad molybdenized non-creep oil is applied to all existing oil points and oil-can applications, including the felt pads for the griffe spindles, but not to the hooks and needles; Rocol Molygear is used for all existing grease points and grease-gun applications and is lightly smeared on all gear teeth; Rocol Anti-Scuffing spray from an aerosol pack is applied to the hooks and needles, thereby enveloping them in a bonded dry-lubrication film of molybdenum disulphide which will withstand up to 100,000 psi without rupture; Rocol Anti-Scuffing paste is applied at the works during assembly to cylinder slides, griffe spindles, cam faces, eccentrics, etc.; and Rocol Molytone 265 grease is applied as required to ball and roller bearings.

Whenever Rocol molybdenized products replace existing greases, the working surfaces should be thoroughly degreased first.

Some interesting facts have been obtained from the weaving shed of 72 Northrop L.F. looms, of one of Britain's principal weavers, which have been lubricated with Rocol molybdenized lubricants for two years. Each loom has a 1 hp electric motor and a pick speed of 160 picks per minute. The looms run continuously on 3-shift operation.

Prior to using Rocol lubricants, lubrication was necessary once a shift. It is now once every two shifts and whereas the load measure during normal operation was 1·9 amp per loom it is now 1·85/1·80 amp. There is less wear of machinery, fewer seizures, with the resultant less breakage of yarn, no over-lubrication and no splashing. In the two years there have been no loom fires, where previously looms occasionally ignited in certain places.

Rocol Molypad is used for all oil-can applications, Rocol Molykiron 30 for oil cups, Rocol Molygear for open gearings, Rocol Moly R.4 grease for bearings and grease gun use and Rocol anti-scuffing paste for the assembly and loom tappets.



Heavy duty electronic weigher. Left to right, control unit; power supply; weighbridge showing load cell

Electronic Weigher

A new heavy duty automatic and continuous weigher for coal preparation, ore mining and quarrying applications, etc., uses a dustproof load cell incorporated in a single idler weighbridge. The weight of the burden on the belt creates pressure on the cell, electrically connected to a stable oscillator which, dependent on the load, induces an unbalanced voltage. This voltage, when amplified, is used to give direct readings of the momentary load. An additional voltage from a tacho-generator, driven on the return belt, is multiplied and integrated with the oscillator voltage. The resultant sum, i.e., total burden conveyed, is indicated by means of counters.

Initial tare and load calibration tests are easily made by using a built-in calibration weight and an auxiliary counting device.

The weighbridge is fitted compactly between conveyor stringers (up to 30° inclination) and can be remotely connected as far as 100 yd from the dustproof electronic control unit. The machine is made by Electroweighers (Birmingham) Limited, Moseley Street, Birmingham 12.

Metallurgical Developments

Many quite important technical advances are reported from overseas. In the following article a number of these are described. A further selection will appear in a later issue.

TECHNICAL development is much like the growth of a plant. It goes in spurts, and 1958–59 has been a year in which one of the spurts has taken place. During and a little before this period, there has been a spate of new materials, new processes, new applications of previously existing materials, some of them originally developed for a single industry. New welding advances and new tools have also been introduced. This article and its successor briefly describe as many of these as possible.

Taking new materials first, a new high–strength bronze has been introduced. This resists corrosion and is of high yield and tensile strength at elevated temperature. The material is a nickel-silicon-bronze alloy, and is available in soft, cold forming and hard tempers. It can be age-hardened to give maximum strength, hardness and electrical conductivity by heating at 480° C for 1½ hr. The composition is 97·5% copper, 1·9% nickel, and 0·6% silicon.

All the standard gunmetals employed at the present time are the result of trial and error. Of recent years, they have been systematically studied, and it is stated as a result of these studies, that none gives the ideal combination of properties required, i.e. uniformly high strength, ductility and pressure-tightness in castings of variable section. It is suggested that a new type of alloy containing 6% to 7% tin, 3% to 4% zinc, 3% to 4% lead, 1·5% to 2·5% nickel, the balance being copper, would be much superior to existing gunmetals. It would be easy to cast, less sensitive to variations of sections, and just as adaptable as ordinary gunmetals to the production of pressure-tight castings, while possessing better properties at elevated temperatures. Castings could be more effectively designed with such an alloy, it is claimed, especially for use in thinner sections, and this would save a great deal of weight so that economies of some magnitude might be realized in valves. The alloy could probably replace the 88-10-2, 86-7-5-2 and 85-5-5-5 alloys.

A precipitation-hardenable alloy of new type has been developed. It contains 26% nickel, 13% chromium, 1·5% molybdenum, 2·8% titanium, the balance being iron. In addition 0·003% boron is included in the composition to give improved ductility. Production of the alloy has attained the stage of commercial development and the principal application is said to be turbine discs.

Naval engineers designing hardware for mine sweepers have been handicapped by the absence of suitable high-strength non-magnetic casting alloys. Consequently, investigation has taken place into the possibility of adapting three types of wrought, age-hardenable austenitic steels for use as castings. A fourth type of steel which had no exact counterpart has also been investigated because of the particular interest afforded by its low alloy content. This is a manganese-vanadium steel containing 0% to 4·5% chromium, 2% to 4% nickel, 14% to 18% manganese, 0·25% to 1·2% carbon, 0·25% to 1·2% vanadium and 0·4% to 3·5% molybdenum. Yield strengths of 44½ ton per sq in. were obtained with this steel.

Two more new precipitation-hardenable materials recently developed contain (a) 0·05% carbon, 0·3% silicon, 0·3% manganese, 15% chromium, 15% nickel, 4·0% molybdenum, 4% tungsten, 3·0% titanium, 1·0% aluminium; (b) 0·25% carbon, 0·3% silicon, 18% manganese, 12·5% chromium, 3·0% molybdenum, 0·2% nickel: (a) is manufactured by a vacuum melting process, and (b) by the arc melting process.

Application of the commercial possibilities of ultra-high-strength steel has been impeded until recently by the belief that tensile strengths above 90 ton per sq in. were inevitably associated with brittleness. Now that this belief has been shown to be fallacious as a result of work on structural materials of high strength-to-weight ratio, the new steels are being put to use. These steels typically contain nickel 1·65% to 2·0%, chromium 0·4% to 0·9%, molybdenum 0·2% to 0·3%, carbon 0·4%. The maximum strength range obtainable is 116 to 125 ton per sq in. These steels, however, could not be given a higher carbon content, nor could they be tempered at a temperature below 200° C.

In consequence, a composition has been introduced which contains typically 0·04% to 0·45%, 1·45% to 1·8% silicon, 0·65% to 0·9% manganese, 1·65% to 2·0% nickel, 0·65% to 0·9% chromium, 0·3% to 0·45% molybdenum, 0·05% min. vanadium. This steel is deep-hardening and transverse ductility in heavy sections is said to be exceptionally good. The steel can be tempered at 310°C and composition is adjustable to give higher strength with acceptable carbon, according to the properties required. For a tensile strength of 130–134 ton per sq in., the steel should have not less than 0·4% carbon.

The development and successful employment in marine engineering of nickel aluminium bronze has led to the introduction of a further related series of copper-base alloys, the basic constituents of which are varied to give the properties desired for particular applications. The nominal composition of these alloys is 11% to 13% manganese, 7% to 9% aluminium, 2% to 4% iron, 1·5% to 5% nickel, the balance being copper. Tensile strengths vary from 45 to 55 ton per sq in. They compare with those typical of aluminium

bronzes and high-strength brasses. The most widely used alloy of the series has an ultimate tensile strength of 45 ton per sq in. and an elongation (as-cast) of 30% to 35%. Proof stress exceeds 20 ton per sq in. Other alloys of the range are designed either for greater tensile strength with somewhat lower ductility or service at elevated temperatures.

Sea-water erosion-corrosion tests having been previously carried out on an iron-containing 90%/10% cupro-nickel in the form of condenser tubes, welded sheet and pipe to determine its suitability as a substitute for copper-nickel of the 70-30 type, and having proved satisfactory, the new alloy has now been investigated to decide its suitability for other applications form, e.g. rod and plate. These tests have given evidence that at 420° C tensile strength ranges from 13 to 20 ton per sq in. for soft to hard materials.

There has been a need for forgeable, age-hardenable austenitic steels for superheater tubing, and a range of austenitic steels has been developed in Britain designed to give alloys with as low an alloy content as is compatible with stress-rupture strength, at temperatures of the order of 732° C which is at least double that of the 18-8 chromium nickel steels; as well as corrosion resistance and freedom from embrittlement under working conditions; forgeability and weldability; and satisfactory mechanical properties.

Steels meeting these conditions have a nominal composition of 0·02% to 0·15% carbon, 14·7 to 20% chromium, 12% to 18% nickel, 0·25% to 2·5% manganese, 0·1% to 1% silicon. Creep rupture strength is achieved by adding copper 2% to 3%, molybdenum 1% to 3%, tantalum or niobium/tantalum 0·5% to 2·06% and nitrogen 0·1% to 0·25%. The steel may also contain up to 1% vanadium.

Stainless steel that is buoyant in water is a new advance, and another is a new metal resembling a petrified sponge, which is said to be nine times lighter than this.

We may now consider the new processes. A new development is the use of platinum-surfaced anodes for the impressed current method of preventing corrosion on ships, as well as on small motor-boats. Further reference will be made to this when considering applications.

A new metal alloy process involves "mixing" ceramic materials with metals, thereby, it is stated, making the metal alloys from three to four times as strong as conventional metals at high temperatures.

Unusual degrees of surface hardness are being obtained in nickel alloy steel by the application, after nitriding, of a high-frequency induction heating cycle. Treatment for about 2 sec suffices to increase the hardness of the nitrided surface from Rockwell C57 to Rockwell C54. The induction hardening treatment causes deeper diffusion of the nitrogen, which gives a greater depth of hardening. Surfaces so produced are highly wear-resistant, and it is anticipated that the new technique will be applied to the treatment of various carbon and low alloy steels.

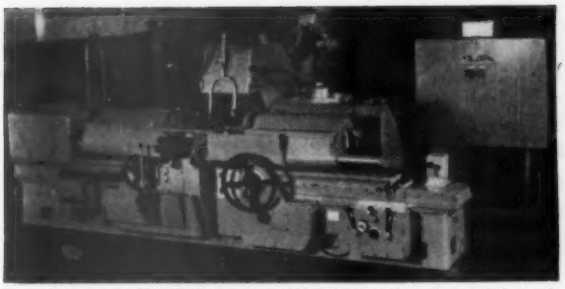
The adherent chromium oxide film present on stainless steels gives them their high resistance to corrosion, but at the same time makes it extremely difficult to give them surface hardness by the nitriding process. Various methods of eliminating the oxide film for this purpose have been tried, without success. Now, however, a salt bath treatment has been introduced which is claimed to destroy the film in 15 min on an 18-8 stainless steel. The solution used consists of about 60% sodium cyanide and 40% potassium cyanide. The parts are placed in this, rinsed in water on removal, and then nitrided. The depth of hard case produced depends on time of treatment. The process is said to be applicable to all stainless steels, which it hardens to values much higher than those of ordinary surface-hardened nitriding steels. Nitrided austenitic stainless steels are said to have improved resistance to fatigue, while maintaining their hardness and oxidation resistance up to temperatures of about 540° C. The nitriding treatment reduces resistance to attack in certain corrosive media, but it is eminently suitable for abrasion-resistance allied with oxidation resistance or non-magnetic properties.

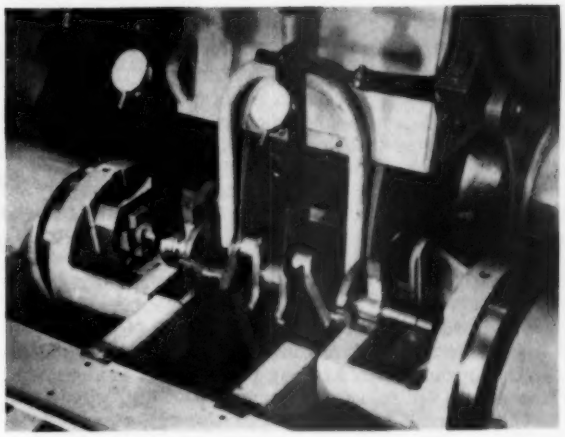
In recent years the demand for investment-cast components of high tensile strength has led to the extension of the lost wax process to a much wider range of materials than those alloys to which originally it was applied. Application of the process to certain grades of steel proved difficult, and it became necessary to develop a steel that could be used for this process. A British firm has successfully produced three materials which have been found suitable. These give high mechanical properties as well as good yield strength, which is essential from the point of view of the designer.

Service failures have been experienced in age-hardenable austenitic 26-15 chromium nickel steels designed for elevated temperatures. These failures have been attributed to variations in methods of fabrication, and as a result investigations have been carried out. These have led to the development of design and fabrication procedures which are claimed greatly to increase the fatigue and stress-rupture service life of bolts of this material.

Much use has been made of conventional metal-spraying processes in building up and reclaiming worn engineering components. When, however, the component is meant for conditions of high stress, the results are sometimes unsatisfactory. Research has therefore been carried out to devise a technique combining the ease and control of metal-spraying techniques with the excellent mechanical properties and adherence of deposits produced by normal welding methods. This has resulted in the development of a new process which involves spraying a powdered nickel chromium boron base on to the surface of the component and then fusing it by exposure to heat from a torch or furnace. This produces a smooth, non-porous hard facing, accurate to within 0·01 in. of finished dimensions. In general the process is applicable to such units as pump rams or sleeves operating under severe service conditions, shafts and rams showing rapid wear, valve plugs and seats requiring frequent renewal, guides and wear plates.

The heat and corrosion resisting alloys and steels are difficult to form and shape, but annular components are now being produced with great success by the new centrispinning process, which is claimed to solve the practical and economic difficulties involved. Centri-spinning meets the demands of the marine engineer for castings exhibiting freedom from physical blemishes combined with adequate mechanical properties throughout the entire cross-section, freedom from axial weakness, satisfactory oxidation—and corrosion-resistance, and adequate weldability.





General view of the Newall-Keighley type HAC dual wheel crankpin grinder, and, right, detail showing the twin-wheel assembly, gauging units and workpiece in the grinding position

Heavy Duty Automatic Crankpin Grinder

A new addition to the range of Newall-Keighley crankpin grinders is designed for high-speed production of small or medium sized four or six cylinder crankshafts by simultaneously grinding two in-line pins. The machine is equipped with two quick approach and synchronized automatic hydraulic steadies, twin dial indicator type caliper gauges for showing when pins reach finish diameter, automatic location of the worktable for positioning and automatic hydraulic throwblocks. All the controls are interlocked and, after initial setting up, the complete operating cycle can be controlled by movement of a single joystick lever. Position of the right-hand workhead is adjustable to permit accommodation of various types of shafts.

In addition to grinding two pins in one cycle the machine achieves considerable production economy in that no time is lost in table indexing, and dressing of peripheries of both wheels and automatic compensation for wheel truing is automatically initiated after each component is ground, and as the cycle takes place during component unload and load time there are no separate dressing contingencies during the life of a wheel.

Maximum and minimum distances between faces of workhead and tailstock spindles are 48 in. and 24 in. and the work centre height is 10 in. The wheelhead can have spark splitter mechanism for lateral displacement of the spindle if required and for synchronization the work-spindle drives are by precision inverted tooth chains. Work rotation is quickly halted by electric braking which causes the fixture to stop revolving when the component is in the unloading position.

A hydraulically operated wheelhead mounted dresser for truing wheel peripheries is available, incorporating twin diamond holders each with micrometer adjustment. Dresser controls for setting purposes mounted on the front of the machine include a dial calibrator with divisions 0–10, each increment representing a reduction in diameter on both wheels of 1/1000 in. The actual dressing consists of one pass with cut applied and return movement with no additional feed; this is automatically brought into effect when the wheelhead retracts at the end of each grinding cycle and is associated with automatic compensation for wheel truing.

The machine is marketed by Newall Group Sales Limited, Old Fletton, Peterborough.

All-transistor Sound Level Meter

To meet the demand for a simple portable yet accurate unit for measuring noise, a new Type 1400E sound level meter has been introduced by Dawe Instruments Limited, 99 Uxbridge Road, London, W5. The incorporation of transistors throughout has resulted in overall dimensions of $8\frac{1}{4} \times 5\frac{3}{4} \times 3\frac{3}{4}$ in., with a weight of only about 4 lb. The use of transistors has also virtually eliminated circuit microphony. Careful attention to circuitry ensures stability of calibration over a wide temperature range. As a result, the new instrument conforms to the proposed International Electrotechnical Commission (I.E.C.) specification for sound level meters, and is claimed to be the world's first commercially available fully transistorized instrument for this purpose.

The unit comprises a crystal microphone, an impedance matching circuit, two attenuators, a high-gain amplifier, weighting networks, and an indicating meter. Both attenuators (one at the input and the other after the second amplifier stage) are operated by a single control knob to give direct measurement of sound level over the entire audio range from 24 to 140 dB. The three weighting networks simulate the frequency response of the human ear to low (40 phon), medium (70 phon) and loud (100 phon) noises. Meter readings therefore provide a close measure of the equivalent loudness of a noise without the disturbing influences of age, prejudice and fatigue, to which all human observers are prone to some extent.

Typical applications are the analysis of engine noise factory noise tests, and noise checks to ensure that engines, ventilating systems, and similar units do not exceed a given noise level.

The instrument is conveniently held in one hand and is switched on by raising the microphone from its fold-away position in a recess in the case. Since transistors need no warming up, a reading is obtained at once. One set of dry batteries provides an operating period of about 60 hr. If the instrument is not required to be mobile, a power pack is also available to enable it to be operated from a mains supply. The new meter also has an output jack into which a frequency analyser can be plugged.

Permanent Magnet Survey

Last month materials and some aspects of design were surveyed. Further design features are now discussed and working data presented

Whatever the initial operating point of the magnet on the demagnetization curve, the state of magnetization is dependent on keeping the domains in alignment. The presence of reluctance in any "working" circuit will inevitably result in a loss of flux through weakening of the bonds. When the reluctance is reduced the flux does not revert to its original value, but subsequently operates on a recoil loop, unless remagnetized, see Fig. 6.

This condition will, of course, normally obtain if the magnet is assembled in a magnetized condition and the effective remanence lowered as a consequence—a strong point in favour of magnetization *in situ*. As a generalization, then, for static applications the working point will remain on the main demagnetization curve if the demagnetization field is that due to (constant) gap alone, but if after saturation the magnet is subjected to any additional demagnetization or cyclic variations in H, the working point will be inside the main curve on a recoil loop. For all practical purposes these recoil loops can be considered as straight lines, approximately parallel to the tangent to the demagnetization curve at B_r, see Fig. 7.

Suppose, for example, the demagnetization effect of the air gap results in the working point being established at A (Fig. 7). If some additional demagnetization effects cause the working point to fall temporarily to B, removal of this additional demagnetization will cause the working point to move back along the recoil loop BB′ to C, and not to A. This would represent a significant change in properties in certain applications, e.g. in a meter magnet.

Stabilization

This effect can be minimized by stabilizing the magnet by subjecting it to a demagnetization force greater than it is ever likely to experience in service. The effect can be studied in Fig. 8. If the stabilizing demagnetization pulls the working point down to D, the subsequent working point would be at F on the recoil loop. In the case of a meter magnet, etc., the instrument would now be calibrated for this working point instead of at A. Any subsequent temporary demagnetization force would then reduce the flux to E and not B, the difference in flux between points E and F on the recoil loop being very much less than the difference between A and B on the demagnetization curve (without stabilization). Further, there would be no permanent loss of flux for the magnet would revert to F as its working point on removal of the temporary demagnetizing force.

All instrument magnets are normally stabilized in this manner before calibration of the complete instrument. Permanent magnet generators may be stabilized by withdrawing and then replacing the rotor, horseshoe magnets simply by open-circuiting after magnetization, and so on. Stabilization is highly desirable where the component involved may be disassembled, when the magnet can be replaced to give the same performance without remagnetization. Failing this, it may be necessary to specify that it is essential that the magnet be remagnetized, if removed from the assembly for any reason.

Optimum design

Normal optimum design requirements for static operation call for the magnet to be operated at the BH_{max} point (and its equivalent recoil loop, where this is related) and for this purpose it is generally assumed that the whole of the magnet operates at the same point. This is not strictly true and, in fact, there can be considerable variation in operating point along the length of the magnet. This effect is most marked with large air gaps and least with small air gaps or where the magnet is provided with substantial soft iron pole pieces. Theoretically, at least, for equal efficiency a magnet should taper in cross section from the crown to the pole faces to the degree required to compensate for leakages,

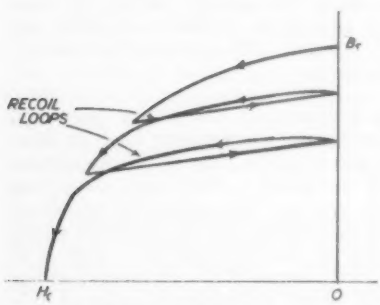


Fig. 6.—Recoil loops

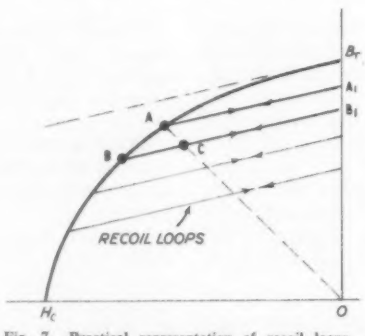


Fig. 7.—Practical representation of recoil loops—straight parallel lines

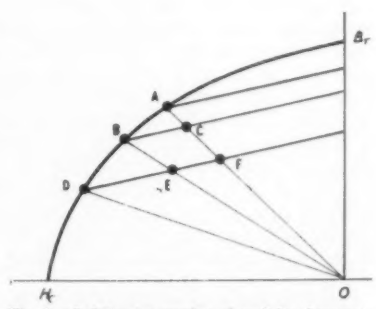


Fig. 8.—Stabilization consists of applying demagnetization field to point D (see text)

but such geometry is not always practical nor easy to arrive at see Fig. 9. A majority of design problems are based on the assumption that the whole of the magnet works at the same point, introducing a correction factor to compensate for flux leakage, and a second correction factor to account for pole-piece losses, curvature and disruption in the flux path.

For minimum magnet volume in any permanent magnet material, the working point selected must correspond with the BH_{max} point. Where stability is essential, it will normally be necessary to work on a lower recoil loop established by stabilization.

Dynamic applications

Dynamic applications call for somewhat different treatment since the magnet will be operating continually up and down recoil loops. Optimum design requirements are then those which allow the magnet to operate on a particular, selected recoil loop consistent with the required performance, without dropping to a lower loop. To assist designers in this respect the Permanent Magnet Association have recently published contours of useful recoil energy for different permanent magnet materials, of which Fig. 10 is typical.

The energy of a magnet working under recoil conditions is partly useful energy and partly leakage energy, with the useful energy for any recoil loop at a maximum when the magnet working point is half-way along that loop. Equally, there is a value of useful recoil energy corresponding to each working point within the demagnetization curve, these diagrams showing contours of equal energy and the point of maximum useful energy.

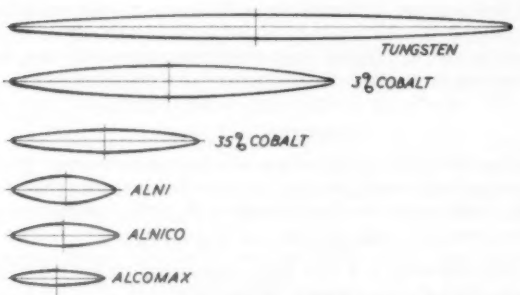


Fig. 9.—Equivalent magnets, proportioned in ellipsoid shape for same working point throughout

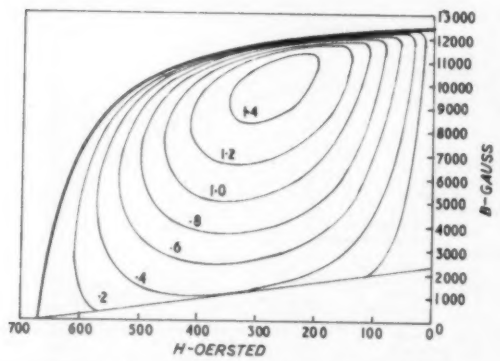


Fig. 10.—Recoil energy loops for Alcomax III (PMA data)

Choice of materials

The majority of present-day permanent magnet requirements are covered by the Alcomax alloys, but where isotropic properties are essential the Alni or Alnico alloys are normally called for. Permanent magnet steels continue to be used where magnet size and efficiency are not of primary importance, or where a degree of machining must be incorporated in the design specification. Straight carbon steels have virtually ceased to be in demand, except again for a minority of old established designs.

Chromium magnet steels, tungsten steels and chromium-cobalt steels are usually produced as forgings and can be machined and fabricated by conventional metal-working methods. Cobalt steels containing up to 15% cobalt are usually produced as forgings or castings which

Table V.—PHYSICAL PROPERTIES OF STANDARD (BRITISH) PERMANENT MAGNET MATERIALS

Material	Specific Gravity	Specific weight oz/cu in.	Specific weight lb/cu in.	Specific resistance $\mu\Omega$/c.c.	Curie point °C
Chromium steel	7·85	4·54	0·284	62	760
6% Tungsten steel	8·2	4·75	0·30	63	760
2% Co 4% Cr steel	7·85	4·54	0·284	60	775
3% Cobalt steel	7·7	4·46	0·279	63	800
6% " "	7·75	4·49	0·280	63	830
9% " "	7·8	4·51	0·282	63	840
15% " "	7·9	4·57	0·286	63	840
35% " "	8·2	4·75	0·30	63	890
Alni	6·9	3·99	0·25	50	760
Alnico	7·3*	4·225*	0·264*	54	800
Alcomax II	7·35*	4·25*	0·266*	50	840
Alcomax III	7·35*	4·25*	0·266*	55	860
Alcomax IV	7·35*	4·25*	0·266*	60	860
Columax	7·35*	4·25*	0·266*	—	860

*Densities are lower with these materials used in sintered form

Table VI.—COMPARISON OF MAGNETIC WEIGHTS & SIZES (Identical performance at BH_{max})

Material	Cobalt-chromium Steel	6% Tungsten Steel	3% Cobalt Steel	35% Cobalt Steel	Alni	Alnico	Alcomax III
Relative Volume	15·5	16·5	14·6	5·4	4	3	1
Relative weight	16·5	18·5	15·3	6	3·7	3	1

Respective values for a typical ferrite are—Relative volume 6·4
Relative weight 4·2

Table VII.—MECHANICAL FEATURES OF STANDARD (BRITISH) PERMANENT MAGNET MATERIALS

Material	Rockwell C Hardness	Manufacture	Design limitations	Machinability	Drilling & tapping
Chromium steel	62	Rolled or cast	None	V. Good	O.K.
6% Tungsten steel	63	Rolled	"	Good	"
2% Co 4% Cr steel	60	Rolled or cast	"	"	"
3% Cobalt steel	63	" "	"	"	"
6% Cobalt steel	63	" "	"	"	"
9% Cobalt steel	63	" "	"	"	"
15% Cobalt steel	63	" "	"	"	"
35% Cobalt steel	63	" "	Few	Rather more difficult	No
Alni	50	Cast	See Article	Limited to grinding	With difficulty
Alnico	50	Cast or sintered	" "	"	With difficulty
Alcomax II	54	"	" "	"	No. Cored holes only
Alcomax III & IV	54	"	" "	"	"
Alcomax S.C.	—	Cast	" "	"	No
Columax	—	Cast	Restricted to solid slugs	Nil	Not even cored holes permissible
Feroba	—	Sintered	Small solid shapes with little or no taper	Nil	No

can be machined, drilled and tapped with relative ease. The 35% cobalt steel, however, is brittle and difficult to machine. In particular it tends to flake if drilled and is not a suitable material for tapping with screw threads, especially in small diameters.

Cobalt steel magnets remain a logical choice where size, complexity of shape or intricacy of machining make it impossible to employ one of the later aluminium-nickel-iron alloys which have severe mechanical limitations. Further data are to be learned from Table VII.

Alni, the first of the dispersion-hardening alloys to be produced on a commercial scale, is the cheapest of this group of alloys and may be selected where a short magnet length is desirable but minimum section is not important. It has, however, largely been superseded by the isotropic Alnico alloy or the anisotropic Alcomaxes. Alnico, although inferior in magnetic properties to Alcomax, is the most powerful of the isotropic permanent magnet materials, with an almost equal coercivity—hence its particular suitability for short, squat magnets.

All the dispersion-hardening alloys (Alni, Alnico and Alcomax) are produced as castings and have very similar mechanical properties—very hard, brittle materials which can only be machined by grinding. They cannot be drilled and where holes are necessary these are usually cored. Where possible, grooves are preferred to cored holes, Small holes, where specifically called for, are best produced by using an oversize core and plugging with a softer metal, which is subsequently drilled.

Generous tolerances are normally called for with these cast magnets and desirable design features call for the avoidance of sharp angles and corners, sharp edges, thin walls and abrupt changes in section. Alnico is rather more tolerant in this respect than the Alcomaxes, particularly as the design of an Alcomax magnet must allow for a magnetic field to be applied during cooling to secure the anisotropic effect. The ideal shape for an Alcomax magnet is, in fact, a simple block form with parallel pole faces. More complex forms may be produced by composite construction, e.g. using a cylindrical or C-shaped Alcomax magnet in conjunction with mild steel pole pieces. Considerable advances have been made in the production of fabricated magnets with mild steel pole pieces permanently brazed to the basic magnet, yielding a blank where the critical sections can be finished by conventional machining methods.

Table VIII.—MINIMUM MAGNETIZING REQUIREMENTS

Material	Min. magnetizing field oersteds	Min. amp. turns per cm magnet length
Chromium steels	600	500
Tungsten steels	600	500
Cobalt steels	1,500	1,200
Alni	2,500	2,000
Alnico	2,500	2,000
Alcomax	3,000	2,400

Table IX.—EQUIVALENTS IN C.G.S. UNITS AND M.K.S UNITS

Criterion	c.g.s. unit	=	M.K.S. unit	Common Symbol
Flux density	10^4 gauss	=	1 weber/sq metre	B
Magnetizing force	$4\pi/10^3$ oersted	=	1 amp turn/metre	H
Magnetomotive force	$4\pi/10$ Gilberts	=	1 amp turn	F
Total flux	10^4 gauss	=	1 weber/sq metre	Φ

Both Alnico and Alcomax magnets can also be made by sintering, with mechanical properties slightly superior to cast alloys, but magnetic properties slightly reduced. Cast Alcomax II, in fact, is superior to sintered Alcomax III. The sintered alloys are particularly useful for the production of large numbers of very small magnets, yielding a better finish and accommodating more complex shapes than can be considered with casting techniques. Initial tool costs for sintered magnets is high and an economic maximum weight for the product is usually of the order of 20-30 grammes.

The semi-columnar and fully-columnar versions of the anisotropic alloys are very limited in the shapes in which they can be produced, for the present at least. Currently they are cast only in simple block or cylindrical forms with complete absence of sharp corners and cored holes. They are also limited in the size which can be accommodated by the processing.

The ferrites or magnetic ceramics are, or course, produced only by sintering and shapes called for must therefore be suitable for pressing into powder compacts. Typical forms are very short "blocks" of generous cross section.

The magnetic circuit

No method of exact evaluation of the magnetic circuit is feasible on theoretical grounds due largely to the difficulty in estimating the magnetic leakage flux, as distinct from the useful flux the magnet is required to give. However, except for cases involving a variable air gap or varying demagnetization conditions it is usual to assume that the magnetic circuit is analagous to an electrical circuit in the sense that the analagous expression of Ohms law holds, i.e.

$$\text{Flux} = \text{Magnetomotive force/Reluctance}$$

For a cross sectional area of A_m sq cm the total flux provided by the magnet is BA_m. Similarly, if L is the length of the magnet in centimetres, the total magnetomotive force across the ends of the magnet is HL_m.

The reluctance is expressed as gap length/gap area, i.e.

$$\text{reluctance} = L_g/A_g$$

using the suffix g to designate gap dimensions. Introducing coefficients to apply a correction for leakage flux (K_1) and losses in the flux path (K_2), this becomes—

$$\text{reluctance} = (K_1 L_g)/(K_2 A_g)$$

K lies between 2·0 and 10·0 depending on length of air gap, etc. K_2 is usually chosen between 1·1 and 1·3, depending on design.

Table X.—FLUX ($4\pi J$ GAUSS) SATURATION

Material	Gauss
3% Chromium steel	15,500
6% Tungsten steel	16,500
2% Cobalt 4% chrome steel	16,000
3% Cobalt Steel	12,500
6% " "	13,000
9% " "	13·500
15% " "	14,000
35% " "	15,000
Alni (Cast)	10,000
Alnico—Cast	12,000
" Sintered	11,200
Alcomax II—Cast	14,000
" —Sintered	13,800
" —Semi-columnar	14,000
Alcomax III—Cast	14,000
" —Sintered	13,800
" —Semi-columnar	14,000
Alcomax IV—Cast	13,500
" —Sintered	12,000
" —Semi-columnar	13,500
Columax—(Cast)	14,000
Feroba—Isotropic	3,500
" Anisotropic	3,900

The complete circuit equation then becomes

$$B_m A_m = \frac{H_m L_m}{(K_1 L_g)/(K_2 A_g)} = (H_m L_m K_2 A_g)/(K_1 L_g)$$

or, rewriting

$$B_m/H_m = (L_m A_g K_2)/(A_m K_1 L_g)$$

The reciprocal of reluctance is defined as permeance. In the complete equation above the whole of the right hand side is known as the unit permeance and may be expressed graphically on the demagnetization curve, as a straight line through the origin. The slope of the unit permeance line will depend solely on the geometry of the design (i.e. magnet and gap dimensions) and the correction factors applied for flux losses. Thus for any given fixed design geometry the working point of the magnet is established by superimposing the corresponding unit permeance line on the demagnetization curve for the particular permanent magnet material, Fig. 11.

From this can be extablished the L_m/A_m ratio for the magnet, whence by fixing either L_m or A_m the final size of the magnet can be calculated, e.g.

Knowing total flux required—A_m = total flux reqd./B_m

Knowing field strength in the air gap—

$$L_m = (H_g L_g K_1)/(H_m)$$

The total volume of magnet material is given by

$$V_m = L_m A_m = (H^2{}_g L_g A_g K_1 K_2)/(B_m H_m) = H^2{}_g V_g K_1 K_2)/(B_m H_m)$$

where V_g = volume of air gap.

The working values of B_m and H_m may be chosen at BH_{max} to give minimum magnet volume; or at some definite point on the demagnetization curve; or on a particular point on a recoil loop, depending on the overall design requirements and operating conditions. Suitable data can be extracted from the tables, or from the characteristic curves for the different magnet materials.

Magnetizing

The advantages of magnetizing after assembly have already been stressed, which practice is normally followed. There may, however, be specific advantages in purchasing magnetized magnets, or magnetizing before assembly, to ensure a degree of stability in the final magnetized magnets must, however, be handled with care (see Handling Magnetized Magnets).

Magnetizing consists simply of exposing the unmagnetized magnet to a sufficiently strong magnetic field in the right direction. It is important that for satisfactory results the magnetizing field be strong enough to produce saturation and unsatisfactory results in the past have often been traced to the use of a magnetizer of insufficient field strength. As a generalization, the field strength available should be at least five times as great as the coercivity of the permanent magnet material.

Small magnets may often be magnetized by being placed in the magnetic field of much stronger permanent magnets but the most usual method of magnetization is by suitable coils carrying direct current. The field strength at the centre of a uniformly wound solenoid of large length can be calculated from first principles

$$H = (4\pi NI)/(10\,L) = (1{\cdot}257\,NI)/L = 1{\cdot}257 \times \text{amp turns per cm}$$

where N = total number of turns
I = current, amp
L = length of coil, cm

Minimum values of ampere turns per centimetre of magnet length are given in Table VIII for different materials.

For shapes not amenable to such treatment, various other forms of magnetizers are available, including the ignitron unit coupled to a.c. mains and utilizing the uni-directional current flowing during one half cycle. This gives, momentarily, a peak half cycle current of the order of 30,000 to 40,000 amp for a single loop copper conductor. Further discussion on this particular aspect of permanent magnets is beyond the scope of this present article.

Temperature effects

The aluminium-nickel-iron alloy magnets are not likely to be affected by operating temperatures up to 550° C. High grade alloy steel magnets may be worked up to about 250° C but the lower grades may begin to suffer loss of properties as low as 100° C. The ferrites are appreciably temperature affected and show an approximate one per cent loss of flux per 5° C temperature rise.

Losses may be of three types—permanent, recoverable on cooling again, and recoverable by remagnetization. It is possible to evaluate these losses only by a study of empirical data, Fig. 12 showing two of a typical series of curves published by the Permanent Magnet Association for a range of four different materials. In this case the difference the performance prior to remagnetization and after remagnetization represents the recoverable loss. The difference between the remagnetized curves and 100% represents the permanent loss.

All ferro-magnetic materials, of course, lose their magnetic properties at the Curie temperature, but recover ferro-magnetic properties on re-cooling below this temperature. Curie points are given in Table V where, it will be noticed, they are quite high for standard per-

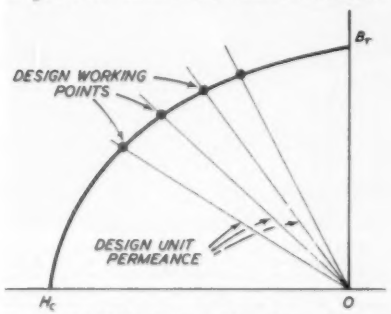


Fig. 11.—Establishing design working point on demagnetization curve

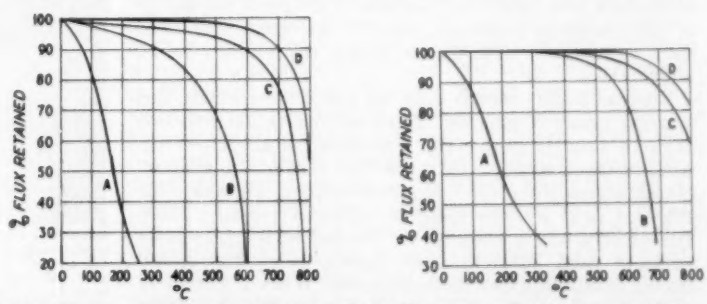


Fig. 12.—Right hand curves show loss of flux after heating. Left hand curve flux recoverable by remagnetization A, 6% tungsten steel; B, 35% cobalt steel; C, Alnico; D, Alcomax

manent magnet materials. Ferro-magnetic materials with low Curie points are invariably of the "soft" variety.

Mechanical shock effects

The effect of mechanical shock on permanent magnet characteristics can only be assessed on experimental lines, ideally conducted with ellipsoid sections which can be uniformly magnetized throughout and thus the whole of the magnet assuming the same working point on the demagnetization curve.

Test figures would appear to indicate that the aluminium-nickel-iron alloys are not greatly affected by shocks of fair magnitude, suffering a loss of flux of some 1% only after a thousand impacts. The most marked loss (approximately 0·25%) is noted with the first few shocks, subsequent shocks having a much smaller and almost constant incremental effect.

The cobalt alloys exhibit a similar characteristic, with a one per cent loss of flux following a relatively few shocks, and a very low incremental loss thereafter. Only with 6% chromium steel is the gradient of the curve steep with increasing number of shocks (of the order of one per cent loss of flux per 100 impacts).

Ageing effects

Losses due to ageing can be anticipated to follow a similar pattern, the aluminium-nickel-iron alloys being much more resistant than the alloy steels and therefore preferably where the magnet has to operate under adverse conditions. Where these involve stray magnetic fields the performance of the magnet can be improved by stabilization (as described previously).

Alloy steel magnets magnetized shortly after hardening will tend to show a loss of flux of some 2 to 3% over the following two or three days and a further much smaller loss of the order of 0·2 to 0·5% over the next few months. From then on the magnet will remain stable unless subjected to upsetting conditions. If necessary, artificial ageing to achive nominal stability can be undertaken with such materials.

Handling magnetized magnets

It must be emphasized—and stressed to operators—that magnetic damage resulting from mishandling is instantaneous and cannot be rectified other than by remagnetization. Hence the correct care in handling magnets is of extreme importance when the purchaser does not possess magnetizing equipment and has to resort to buying magnets in the fully magnetized condition. Manufacturers' instructions should therefore be adhered to rigidly, with magnets kept in original packings until required for use, not allowed to touch steel shelving, etc., nor near electric motors or other possible sources of magnetic fields. Gauges and tools for inspection and handling magnetized magnets should be of non-magnetic materials, and the operators should be fully conversant with the necessary precautions to be undertaken.

Specific points which may be mentioned under this heading concern packing. Provided individual magnets are of a suitable shape (e.g. horseshoe), a keeper of soft iron, of cross section about one-half that of the magnet, placed across the poles will almost entirely eliminate the external field by providing an efficient closed circuit. Failing this, where magnets are stacked with unlike poles adjacent (and adjacent pairs crown to crown) closed circuit conditions can be maintained. When it comes to separating magnets in a pair, however, this should be done with a direct pull, rather than sliding apart. The latter action can result in severe distortion of the poles. Equally, the pole of one magnetized magnet should never be allowed to touch the crown of another.

Testing

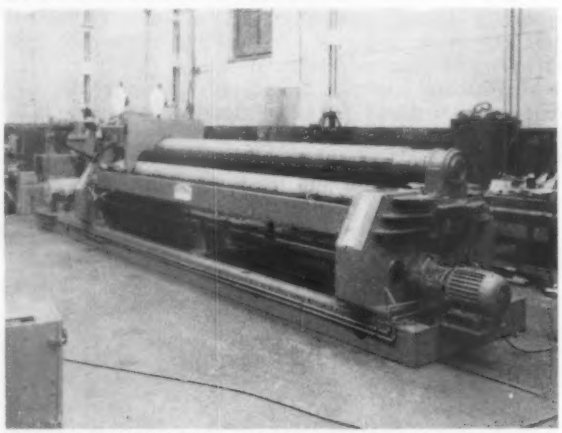
Whilst the subject of testing permanent magnets is beyond the scope of this present article it can be mentioned that standard instruments and standard methods have been developed for the rapid testing of finished magnets. The fluxmeter is a portable instrument of the galvanometer type which is used in conjunction with a search coil to determine either the total flux or some specific region of flux. The gaussmeter utilizes a moving coil ammeter search element (or a small permanent magnet) to give direct readings of flux without relative motion. The direct reading magnetometer utilizes a small pivoted permanent magnet in the form of a probe which, when inserted normal to the field being tested, rotates the indicating needle over a calibrated scale. Various other comparators are also in use, including the B.S.I. (or M.L.) panel which enables the whole demagnetization curve to be established, or a spot check made at any point on the curve.

Rotol Metal Finishing

Through many years of research, Hans Oetiker Company, Horgen, Switzerland has developed a method of polishing and deburring mass produced metal parts called the Rotol method. The process uses mineral grains of extreme hardness together with especially developed chemicals in a rotating drum. Polishing grains are sized from 2 mm to 40 mm. For treating extremely difficult shaped metal parts, grains smaller than 2 mm are used as an additive.

For the whole treatment of all kinds of metal only two chemicals are used. These serve for degreasing, derusting, deburring and polishing. An additional chemical will protect metal parts from rusting after treatment.

Rotol polishing- and deburring-drums are rotating metal drums lined with soft rubber. The covers of the drums shut hermetically and can be bolted; safety valves prevent explosion and electrical equipment is thoroughly insulated. A time switch enables rotoling night and day without supervision.



BENDING ROLLS FOR SOUTH AFRICA.—This 4-roll initial pinch type plate bending rolls has recently been designed and built for South Africa by The Bronx Engineering Company Limited, of Lye, near Stourbridge. The machine is for rolling mild steel plate 14 ft wide by 11 gauge to 13 in. i.d., and the same width by 10 gauge to 18 in. i.d. The rolling speed is 18 ft per min. There is an auxiliary drive to the side bending rolls and a prematically operated swing-down housing which counteracts the dead weight of the top roll. Completed cylinders are removed by pneumatic push-off. Large indicators show the roll settings

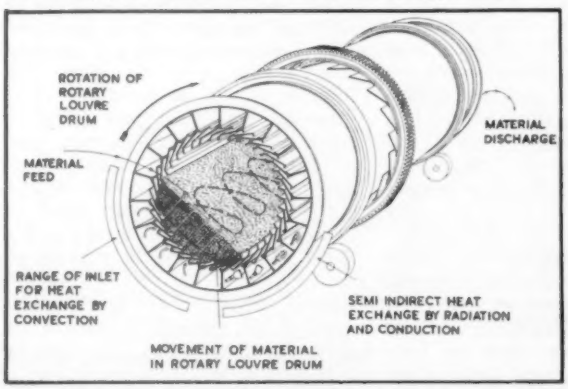
Carbon Monoxide Determination

Carbon monoxide is a colourless odourless gas formed as the result of the incomplete combustion of carbonaceous materials. When respired in the lungs it unites with the haemoglobin of the blood, preventing the passage of the normal quota of oxygen to the tissues. A concentration of about 400 p.p.m. carbon monoxide in air is sufficient to produce toxic effects in human beings. Individual susceptibility to the gas varies and depends upon other environmental conditions, and upon the duration of exposure.

Dangerous concentrations of carbon monoxide may arise in many situations, such as in coke oven plants, foundries, gas works, steelworks, etc. Carbon monoxide can also occur in the exhaust gases from internal combustion engines and in the smoke from fires. In mines the gas may be produced as a result of explosions in over-rich atmospheres of fire-damp, or following shot-firing.

At the new Research Laboratories of the Cambridge Instrument Company Limited a new device for determining carbon monoxide is under development. Its technique is an extension of the well-established methods, in which a catalyst is used to promote the oxidation of carbon monoxide in excess air, the resulting temperature rise during the exothermic reaction being used to estimate the amount of carbon monoxide originally present. The novel test-cell design under development enables high sensitivity and rapid response to be obtained with low rates of gas-flow. The apparatus dimensions are much reduced compared with those of some of the earlier equipment produced by the company, of which an example was the Mersey Tunnel monitoring and recording equipment. These were installed in 1934, and are still in continuous use.

The experimental apparatus represents the first stages in the development of small, semi-portable equipment for use in road tunnels, underground workings, underground car-parks, and other similar sites where conditions may preclude the use of more bulky apparatus.



When this dryer rotates the material travels lengthwise along the heated louvres. The absence of draught prevents loss of fines

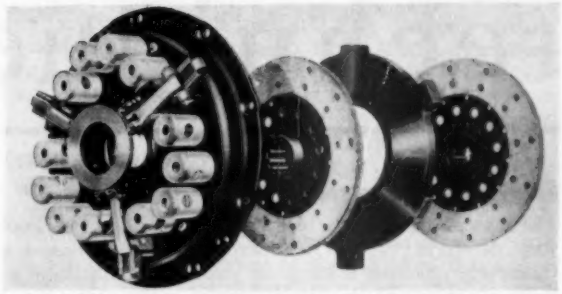
Dryer for Fine Powders

A highly efficient method of drying and cooling very fine materials using the rotary louvre principle has been developed by Dunford & Elliott Process Engineering Limited, Linford Street, London, SW8.

The rotary louvre drying and cooling equipment consists of a rotating horizontal drum with a series of internal radial plates on which the material being processed lies. Usually a current of warm or cold air which is admitted through a series of tangential louvres passes through the bed of material while this is slowly turning over and is travelling to the discharge outlet, but in the new system of operation the carrying away of fine materials is presented by eliminating the current of air and effecting the heat transfer by heating or cooling sections of the internal louvres before they enter the bed of the material. When heating, a flame or alternatively hot air is applied directly to a number of louvres which in turn rapidly transfer their heat to the material. When cooling, sections of the louvres cooled by air successively extract the heat from the hot material.

This system of heat exchange by conduction (for which a patent has been applied) can be supplemented by a small volume of hot or cold air passing through the material bed at a velocity to suit the fineness of the material being processed and as the material does not at any stage drop through the air current, a negligible amount of fines is carried away.

This method has been used with great success in a number of applications, two typical ones being the drying of black iron oxide filter cake in which the moisture content was reduced from 25% to 0·1% and the processing of a catalyst based on diatomaceous earth in very fine powder form. In this latter case the moisture content was reduced from 6·6% to 0% the maximum temperature which the material reached during processing being 400° C.



DOUBLE CLUTCH.—This new Borg & Beck clutch design in 10 in. and 11 in. sizes is ideally suited to those applications where it is desired to provide, in one compact unit, clutches for the main drive to the wheels and for the power take-off. The unit consists of two separate and independent clutches mounted in tandem within a single robust cover, which is bolted to the flywheel in the usual manner. The cover contains the main and intermediate pressure plates, which are of rugged construction and generously proportioned to aid heat dissipation. The construction ensures a particularly compact assembly which can be relied upon to provide long and trouble-free service within its capacity under the most arduous conditions of operation. The makers are Automotive Products Company Limited, Leamington Spa

Wall Bracket for Gas Regulator

A simple wall bracket, with brass block adaptor and metal tube coil for fitting into the top of a gas cylinder saves many regulator repair bills. Single and twin cylinder versions are included in the new 1960 range of equipment by Weldcraft Limited, Windsor Works, Slough, Bucks. The adaptors overcome the damage caused to regulators normally fitted direct to the top of cylinders. When the cylinders are being changed the regulators are often mistreated and dropped on the bench. More damage is caused to the regulator's sensitive mechanism by hammering the bottle nut home. With the wall bracket, the regulator is free from rough treatment and is fixed permanently, no matter how many times the cylinder is changed. Prices are, for single types, £4. 12. 6., and twin models £6. 15. 0.

technique

—devoted to the discussion of practical problems
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Quick Change Chaserhead

The chaserhead about to be described was designed for large diameter threading, covering a range of sizes from 12 in. to 30 in. dia. On such large threading jobs, sixteen chasers may constitute a set. The time saving feature of this design concerns the cutting out of much "down time" when chasers have to be removed for grinding and a fresh set mounted. The normal procedure with most standard chaserheads is to unship the front, or keep plate, in order to remove the dulled chasers. The keep plate on a chaserhead threading 30 in. dia is a respectable weight and it cannot be removed single handed.

Studs and nuts secure the keep plate to the chaserhead, and in the standard chaserhead, its removal demands the loosening and removal of sixteen nuts and their replacement after fresh chasers have been mounted. This, of course, refers to large diameter threading, and it all takes time. Nuts frequently fall down into the swarf pan and have to be fished out. The noses of the holding studs become damaged with frequent mounting and dismounting of the heavy keep plate. It was with a view to being able to remove dulled chasers and mount replacements without having to remove and replace the heavy keep plate that the quick change head was introduced.

Fig. 1 is a front elevation of the chaserhead showing the keep plate removed. It consists of the chaser ring A with slots machined to house the chasers B and the cam ring C operated by handle D. Above each cam path E is seen a scroll F. The chasers are not directly connected to scroll F; instead, they are connected by means of a link G, more clearly seen at Fig. 2 showing the cam ring C in section and chaser B with keep plate H added. The number of slots formed in keep plate H conforms to the number of chasers mounted in the head. Those slots house the links G which have two projections on their inner face.

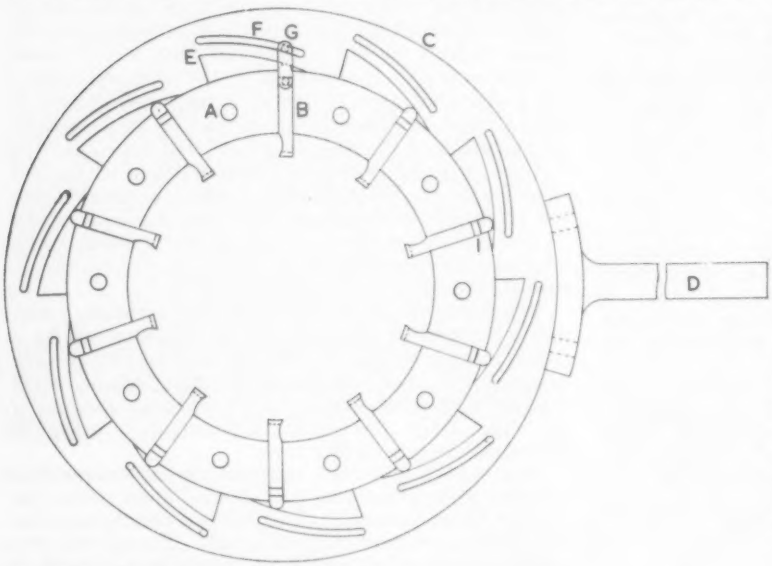


Fig. 1.—Front elevation of quick change chaserhead with keep plate removed, showing, at top, link G in engagement with chaser B and scroll F

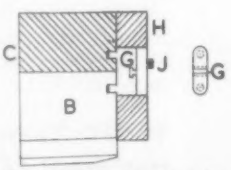


Fig. 2.—Section view of cam ring C and keep plate H, chaser B with link G and stopper bar J.

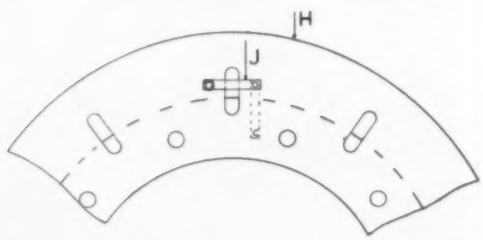


Fig. 3. (Right)—Plan view of part of keep plate H, showing slots for links G and stopper bar J.

Each chaser has a slot I cut in its front face as seen at Fig. 1. The chasers are mounted in the head with the keep plate fixed in position. On mounting, they are passed into their slot from the bore of the head and are pushed outwards, hard against the cam path E. The chasers are held in that position with the left-hand, while the links G are pushed through the slots in the keep plate H with the right. Figs. 1 and 2 show one link in position, connecting chaser B with scroll F in the cam ring, one projection engaging in slot I in the chaser, the other engaging scroll F. Each link is furnished with a T-slot, in conjunction with which a T-shaped key is used to move the links in or out of engagement as required. This key is made of flat stock and is given a half turn after engagement with the T-slot in the link G.

Fig. 3 is a part plan view of keep plate H with slots for links G. Each slot is fitted with a hinged stopper bar J to prevent the links from being pulled out completely on disengagement from the chaser B. One hinged stopper bar is shown, full line, in the working position and chain line in the off position. A shouldered pin at each slot, having a large diameter head, supports the hinged stopper bar in the working position. It will be seen from Fig. 2 that when link G is pulled back against the stopper bar J, the two projections on the link are clear of the chaser and cam ring C. Chaser B can thus be withdrawn with keep plate H still in position. The saving of time when changing sets is considerable.

When dulled chasers have to be removed, each slot is given a sharp

blast of compressed air to remove any fine swarf which may have found its way into the slots, this more especially in the case of the slots located below the centre line of the chaser head. In the operation described, the work revolves and the chaser head remains stationary, except for a vertical and horizontal float to compensate for any slight misalignment in the workpiece.

—D.M.

Tractor Parts Produced by Automation

A production line, 150 ft long in the Glasgow works of Caterpillar Tractor Company Limited, is fed at one end with metal pieces, and at the other end discharges tractor parts hardened, cleaned and tempered. The hardening furnace, the quench tanks and quenching mechanism, and the associated conveyor line were all designed and supplied by the Electric Resistance Furnace Company Limited. The metal parts travel through the complete process in two lanes on a driven roller conveyor. After being cut to size they enter an Efco roller hearth furnace where they are heated to 870° C. As they leave the furnace, parts to be water quenched pass through water sprays. Parts to be oil quenched are automatically collected in batches within the furnace and then hurried along the line to an oil quenching station. After the hardening process the parts move into an Efco wash booth where all traces of oil are removed before they enter heating inductors to be tempered. The parts are finally cooled by water spray before reaching the discharge end of the line.

The progress of the parts along the line is interrupted by some of the operations including the oil quenching process. To maintain the maximum rate of production the roller conveyor is arranged in sections, each with its own independent drive, and sections can be speeded to hurry the parts as necessary from one operation to the next. The overall conveyor speed is variable between 1 and 5 ft per min but after the delay caused by the cutting operation the parts move to the furnace at speeds up to 15 ft per min.

The Efco roller hearth furnace has a heated chamber 50 ft long, 3 ft wide and 2 ft high. It is heated by nickel-chrome elements mounted in the roof, the side walls and under the hearth. The elements are mounted away from the brickwork to give maximum heat dissipation and are arranged in four independently controlled zones, those in the final zone being positioned to compensate for heat losses through the door. Insulated and counter balanced doors are at both ends, the exit door being made of heat resisting alloy and water cooled. The rollers throughout the furnace are of heat-resisting steel and they can be turned by hand in the event of a power failure.

Temperatures in the first three zones are controlled with indicating instruments and in the fourth with a strip chart temperature recorder. All four zones are protected from overheating by instruments which give audible warning if they come into operation.

Immediately beyond the furnace is the water quench station where eight jets together delivering 400 gpm of water at a pressure of 80 psi are directed on to the tractor parts. The water is pumped from, and returns to a tank, 8 ft long, 6 ft wide and 2 ft high mounted on the floor beneath the conveyor. It is fitted with baffle plates to trap scale and with a chute for scale removal. All internal metal parts are treated to resist corrosion. The temperature of the quenching water is controlled automatically with a temperature indicating instrument which operates a valve in a water supply line. The water quenching station is covered to the full width of the conveyor with a metal hood.

Throughout the water quench area the rollers of the conveyor are of hardened stainless steel and have sealed bearings to keep out water and water scale. Adjustable guide bars on the conveyor supports ensure that the parts are properly aligned to pass through the quenching jets.

Parts to be oil quenched are subjected to an automatic quenching sequence initiated by photo-electric cell devices installed within the furnace chamber. Several cells are used to cope with the range of part sizes being processed. The sequence starts with the retarding of the parts inside the furnace until a suitable batch has been assembled. The batch is then hurried from the furnace to the oil quenching position beyond the water quench station at a speed of up to 140 ft per min. At the oil quenching position a section of the roller conveyor serves as a quench table. The table awaits its full load and then descends into an oil quench tank, keeping the parts immersed for a preset time. When the parts are raised from the quench tank they are again hurried forward to catch up with the batch ahead.

The oil quench tank is 10 ft long, 6 ft wide and 2 ft 9 in. high and is fitted with oil filters and a mesh basket for the collection and removal of scale. The oil is fed by a circulating pump at 350/400 gpm through a multitude of nozzles so designed and positioned as to direct the flow of oil up over the parts being quenched. Like the water quench station, the oil quenching position is covered with a full width, metal hood.

After quenching, the parts move to the Efco wash booth where they are sprayed first with an alkaline solution to remove oil and then with hot water. The spray jets are positioned to ensure that all surfaces of the parts are cleaned. The rinsing water is steam heated and its temperature automatically controlled. The section of the conveyor is also fitted with stainless steel rollers.

From the wash booth the parts are carried to induction coils fed from high frequency generators. They remain stationary within the coils during heating for tempering, and are subsequently cooled by passing beneath overhead water sprays. Some 6000 lb of tractor parts are discharged from the production line every hour.

Shrink Fitting with Liquid Nitrogen

A four-ton guide stalk on a 12,000 ton trimming and bending press has been shrunk by the use of liquid nitrogen before being fitted into its housing. The operation, which took place in Glasgow, resulted in a perfect fit without distortion. The method, using 45,000 cu ft of liquid nitrogen, was adopted in preference to expansion by heating of the cast steel housing into which the guide stalk was to fit. To have used the older method would have meant heating the casting for up to eight hours, during which time distortion would almost certainly have taken place. By using liquid nitrogen, manufactured and supplied by British Oxygen Gases Limited, a saving of four hours was obtained, and there was no distortion to either component.

Earth Leakage and Earth Fault Protection—V

Earth Electrodes and Protective Multiple Earthing of Neutral

By J. L. WATTS

WHERE protection against dangerous earth-leakage currents is provided by excess-current devices, such as fuses or overload circuit-breakers, the I.E.E. Regulations require that the exposed metalwork which is to be earthed shall be connected to an earthing lead, provided by the supply authority, which affords a metallic return to the earthed point of the supply system, or to an effective earthing electrode buried in the ground. These regulations call for the earthing lead to be connected to the metalwork at a point which is as near as possible to the consumer's terminals.

Earthing to water piping

An urban water supply system, which is carried in underground metal pipes having metal-to-metal joints, may act as an effective earth electrode in many cases; but it should be noted that metal water service pipes are frequently fed from non-metallic underground water pipes, which are unlikely to act as an efficient earth electrode. Where water piping is used as the earth electrode the connexion should be made as near as practicable to the point where the piping enters the ground. This is to avoid volt drop on the piping between the ground and the point of connexion of the earth-continuity conductor if connected at some other point on the piping, due to earth-fault current. Under earth-fault conditions the volt drop between two such points on the piping would be equal to the product of the fault current (amps) and the impedance (ohms) of the piping between the point of connexion and earth. A bonding lead must be connected across any water meter, and the water main should not be used for earthing without the permission of the water-supply authority. A gas pipe must not be used as the earthing electrode.

U.S.A. and Quarries Regulations

It may be noted that regulations in the U.S.A. require the exposed metalwork to be connected to a metallic underground water pipe system where possible, or to the metal frame of the building if it is effectively earthed; or to other local metallic underground systems such as piping, tanks or the like. However, where such systems are not available the earth electrode must consist of a driven rod, buried pipe, buried plate or other approved device, of resistance not exceeding 25 ohm if practicable.

The Quarries (Electricity) Order, 1956, requires that where the electrical resistance between the earth electrode provided for the exposed metalwork and that provided for the system neutral point exceeds 2 ohm, the two electrodes must be connected together by means of a conductor of cross-sectional area not less than 0.022 sq in. However, if the neutral-point earthing electrode is inaccessible to the consumer, the resistance of the earth electrode for the exposed metalwork must not exceed 2 ohm. As will be seen later, with an earth-electrode resistance of 2 ohm on a supply of 240 volt between phase and neutral earth-fault currents on circuits protected by fuses rated at more than 60 amp are unlikely to be cut off, and dangerous conditions could persist on circuits protected by fuses of even lower rating.

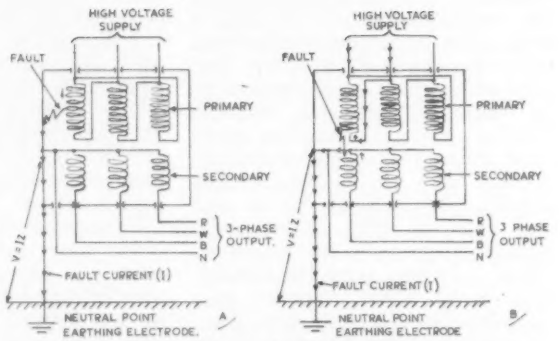


Fig. 1.—Possible faults on primary windings of transformers

Effect of transformer faults

A low resistance is also required for the neutral-point earthing electrode so that excess current protective devices can cut off earth-fault currents on a load circuit; and also to limit the voltage between the neutral point and earth when an earth fault occurs on a load circuit, or the insulation breaks down on the primary windings of the supply transformer. Fig. 1a indicates the path of fault current in the event of an earth fault on the primary windings of the supply transformer. Until the high-voltage supply is cut off by the protective devices on the primary side, the volt drop between the transformer tank and the general mass of earth will be equal to the product of the fault current and the impedance of the tank-earthing electrode. If the secondary neutral point is earthed by the same electrode as the tank, as shown, a similar voltage will exist between the neutral point and earth in the event of an earth fault on the primary.

Fig. 1b shows the path of fault current in the event of a short circuit between the primary and secondary windings of the supply transformer. Again, until the current is cut off by the primary protective devices, the voltage between the secondary neutral point and earth will be equal to the product of the fault current and the impedance of the neutral-point earthing electrode. It is particularly important that this volt drop be limited when the exposed metalwork on the consumer's installation is bonded directly to the neutral point.

Earthing of transformers

With certain minor exceptions, the I.E.E. Regulations require that one point of the secondary windings and metalwork (other than current-carrying parts) of any

transformer must be earthed, unless the primary and secondary windings are mounted on separate limbs of an earthed core or are separated by an earthed metal screen.

The Electricity Regulations of the Factories Acts require that, where a step-down transformer is fed at 3,000 volt or over, one pole or the neutral point of the secondary windings must be earthed; or a potential-operated relay be fitted between the secondary windings and earth to disconnect the supply if the voltage to earth exceeds a pre-determined value; or an earthed shield or equivalent be provided between the primary and secondary windings; or an electrostatic spark-gap device be connected between the secondary windings and earth.

The Electricity Supply Regulations require that, where energy is transformed, suitable provision shall be made, either by earthing a point of the lower-voltage system or otherwise, to guard against danger by reason of the system becoming accidentally charged above its normal voltage by leakage from, or contact with, the system at the higher voltage.

In premises coming under the Quarries (Electricity) Order, 1956, it is required that, where the secondary side of a transformer operates at more than 125 volts, the neutral point of the secondary windings must be earthed at one point only. In premises covered by the Coal and Other Mines (Electricity) Order, 1956, suitable provision shall be made to guard against danger arising from the charging of the lower-voltage component of a transformer by contact with, or leakage from, the higher-voltage component.

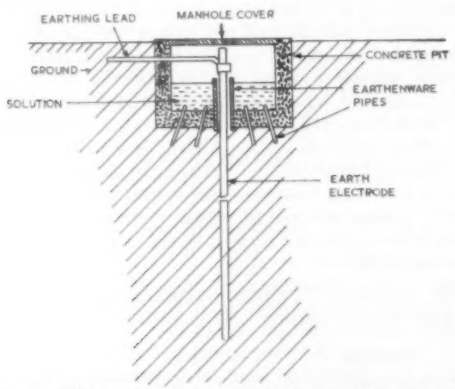


Fig. 2.—A suitable arrangement for artificial treatment of an earth electrode

In most cases the required protection is provided by earthing the neutral point of the secondary windings. As mentioned later, special earthing arrangements are required by the Ministry of Fuel and Power in the case of transformers used to supply a system having multiple earthing of the neutral.

Types of earth electrodes

An effective earth electrode must have a low resistance to the general mass of earth if it is to provide adequate protection against the risk of fire or shock on circuits protected by devices requiring an appreciable current to operate them. This applies equally to the neutral-point earthing electrode and to any separate electrode provided for exposed metalwork. The total resistance between an electrode and the general mass of earth is due to the contact resistance between the electrode and the adjacent earth, plus the resistance of the earth itself round the electrode. The resistance depends on the composition of the soil in contact with the electrode, which governs the resistivity or specific resistance of the soil; the temperature of the soil; its moisture content; the composition of the surrounding soil; together with the size, shape and depth of the electrode.

The lowest soil resistivity is likely to be obtained in clay, whilst sand and rock are likely to have a high resistivity. Preliminary tests of soil resistivity may be advisable to determine a suitable position for an earth electrode. It is, of course, desirable that the moisture content of the soil should not vary greatly with the seasons, and the electrode should normally be no less

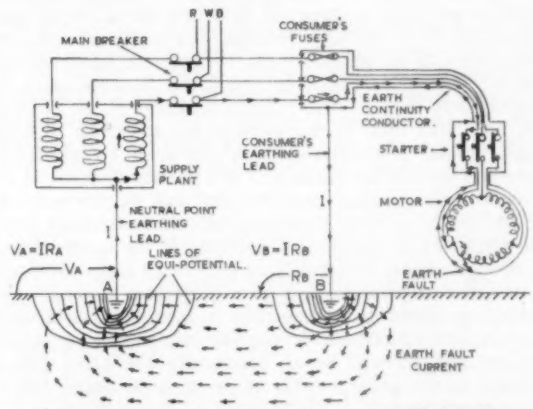


Fig. 3.—Passage of earth-fault current between two earth electrodes

that 2 ft below the surface of the ground to avoid freezing of the soil round the electrode in winter. In some cases it may be necessary to lower the resistivity of the soil in the vicinity of the electrode by treating this with a solution of salt, magnesium sulphate, copper sulphate or calcium chloride. Fig. 2 shows an arrangement which may be adopted where such periodical treatment is necessary.

Satisfactory earthing electrodes have been constructed of copper, cast-iron or galvanized iron plates, having an area of 4 to 15 sq ft, which are buried vertically three to four feet below the surface, and are packed round with a bed of broken coke to a thickness of about 12 in. The coke has the advantage of increasing the effective size of the electrode. Copper strips laid in long shallow trenches may provide a good earthing electrode if the top soil is of low resistance and is subject to little seasonal variation.

Another type of electrode consists of copper-clad steel rods or pipes about $\frac{3}{4}$ in to 1 in dia, or D-section rods, which are driven into the ground a distance of 10 to 15 ft. Such electrodes have advantages where there is a high moisture content a few feet below the surface. A number of such pipes or rods should be used, these preferably being spaced about 10 ft apart and connected in parallel above the surface of the ground. Any underground connexion to an earth electrode should be made by brazing or welding.

In any case it is a good plan to use at least two earth electrodes so that the resistance of each can be tested without having to disconnect the protected metalwork from earth.

Resistance Area and Voltage Gradient

When current flows between an earthing electrode and earth a voltage will be created between the electrode and the general mass of earth, this being equal to the product of the fault current (amps) and the resistance (ohms) between the electrode and the general mass of earth. The reactance of an earth electrode is negligible, so its impedance is equal to its resistance. As will be seen from Fig. 3, there will then be a volt drop V_A between the neutral point and earth, and a volt drop V_B between earth and the separate electrode provided for the faulty plant.

As a result of the fault current, the voltage on the ground in the vicinity of either electrode will differ from the (zero) voltage of the general mass of earth. Shells of equal potential or voltage will then be created round each electrode. The voltage between the earth round the electrode and the general mass of earth will fall from the value V_A at the electrode to zero some distance away, as indicated in Fig. 4. The voltage gradient R, or voltage per foot difference of radius from the electrode, will be much greater at a short distance O-P from the electrode than will the voltage gradient S at a greater distance O-Q. However, the voltage gradient may not be the same at points on the ground which are the same distance from the electrode in different directions, if the composition of the soil varies. The resistance area of an earth electrode is assumed to be bounded by a perimeter at which the voltage gradient is so low that it cannot be measured with ordinary instruments; outside this perimeter, points on the ground will be at practically the same (zero) voltage as the general mass of earth, even under earth-fault conditions.

During the passage of earth-fault current there will thus be a difference of voltage between points on the ground within the resistance area of the earth electrode. This might result in shock to persons, and possibly serious shock to animals, standing near the electrode. If there is another earth electrode inside the resistance area this also will reach a certain voltage to the general mass of earth, when earth-fault current flows through the first electrode. For instance an earth electrode at a distance O-P from an electrode A would be at a voltage T-O to earth when fault current through A caused this to be at a voltage V_A to the general mass of earth, as in Fig. 4. This might interfere with the operation of protective devices used in connexion with the second earth electrode. Minimum voltage gradient is likely to be obtained by using a large earth electrode, although the resistance of the electrode might still be high if the soil had a high resistivity.

It may be noted that in large U.S.A. substations, use is made of buried wire electrodes with driven rods extending over the entire area of the station to ensure a uniform voltage gradient over the whole area of the station. Station fences are generally connected to the earthing system; together with a buried wire along the station perimeter which is connected to the fence at regular intervals, except where the fence is remote from the substation structure. The Electricity Supply Board of Eire require that, in certain circumstances where hooved animals have access to the earth electrode, it shall be at least 18 in below ground level.

Testing the resistance of an earth electrode

The resistance of an earth electrode may vary from time to time due to variation of moisture content of the soil or dilution of salts, etc., and may also increase during the passage of earth fault current which may dry out the soil if not cut off quickly. If it is required to measure the resistance of an earth electrode, alternating current should be used in order to avoid errors due to electrolysis and/or stray currents in the ground.

Fig. 5 shows a suitable instrument and circuit for earth-electrode resistance measurement. Alternating current from the test set is passed between the electrode A under test and an auxiliary electrode B, which must be at sufficient distance from A that the two resistance areas do not overlap. A minimum spacing of about 80 ft may be adopted for a trial measurement. The instrument divides the volt drop between A and a third electrode or voltage spike V, which need not have a very low resistance to earth, by the current passed between B and A; the ohmmeter giving a direct reading of the resistance of A ohm. It should be noted that if the resistance areas of A and B overlap, the indicated resistance will, however, be less than the true value. Also if the voltage spike V lies in the resistance area of A, the voltage between A and V will be less than that between A and the general mass of earth, giving a reading which is too low. Similarly if V lies in the resistance area of B, the indicated resistance will be too high.

When V is correctly placed outside the resistance areas of A and B, the reading of the instrument should not

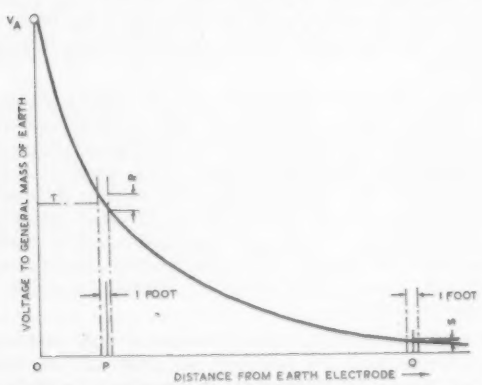


Fig. 4.—Voltage to general mass of earth and voltage gradient round an earth electrode under earth-fault conditions

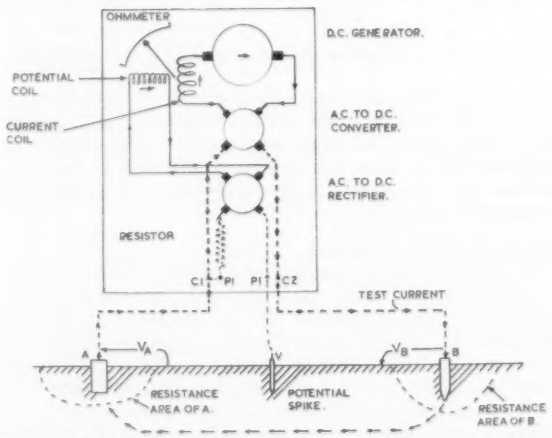


Fig. 5.—Method of testing resistance of an earth electrode (Evershed & Vignoles Limited)

vary when V is moved to a new position outside the resistance areas. Since the resistance of the general mass of earth between the resistance areas of the electrodes is negligible it is impossible to have too great a spacing between A and B for testing. To determine whether the spacing of the electrodes is adequate for accurate test results, three readings should be taken. One with the given spacing, another with V 20 ft nearer to A, and a third reading with V 20 ft further from A. If the test results are approximately the same, the mean may be taken as the resistance of A. If the results differ appreciably this indicates overlap of resistance areas. The tests should then be repeated with greater spacing between all three electrodes.

Use of a return conductor to the earthed neutral point

As will be seen later, it is often difficult to obtain a sufficiently low resistance at a consumer's earth electrode, and/or at the neutral-point earthing electrode, to ensure satisfactory protection against earth-fault risks on circuits which are protected by devices requiring a high operating current, if earth-fault current has to pass through both these electrodes.

One solution to this difficulty is to connect the consumer's earthing terminal T directly to the earthed neutral point P by means of a substantial return conductor, as shown in Fig. 6. It is preferable for this return conductor to run underground; some supply authorities use the cable sheathing for this purpose and provide an earthing terminal connected to this sheathing on the premises of the consumer. A separate return conductor may, however, be used, although its reactance may then be more than that of the cable sheathing. With this system earth-fault current on metal-clad and bonded consumer's plant does not have to pass through any earth electrode, and it is often practicable to keep the impedance of the earth-fault loop sufficiently low for this to be effective on circuits controlled by protective devices requiring quite high operating currents.

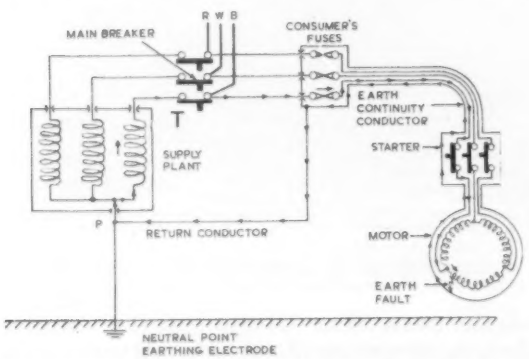


Fig. 6.—Protection against earth faults provided by direct connexion to earthed neutral point of the system

It should, however, be appreciated that if the neutral point P reaches an appreciable voltage to earth a similar voltage is then liable to exist between the exposed metalwork of the consumer's installation and earth, which could be dangerous. Such a voltage might occur due to an earth-fault on other plant, the metalwork of which is not bonded to the earthed neutral point. Such a fault might occur on the premises of another consumer fed from the same supply plant. A similar voltage might occur due to a breakdown between the primary and secondary windings of a supply transformer; or due to an earth fault on the primary windings of a supply transformer if the transformer core is not earthed to a separate earth electrode outside the resistance area of the neutral-point earthing electrode. This sytem should, therefore, only be adopted after consultation with the supply authority, and an additional earth electrode may be provided for the exposed metalwork of the consumer's plant to guard against the risk of interruption of the return conductor, as by fusing of the supply cable.

Protective multiple earthing of the neutral

Difficulties in providing earth-fault loops of sufficiently low impedance to ensure safety by devices operating on appreciable currents have led to the adoption, in some areas, of a system whereby the neutral conductor is used as the return conductor for earth-fault current. This P.M.E. system is indicated in Fig. 7.

In this country such a system requires the approval of the Minister of Fuel and Power, with the concurrence of the Postmaster General. They require that a separate earth electrode be fitted at each of the following points: (a) some part of the metalwork associated with the windings at the higher voltage (as at F in Fig. 7); and (b) the neutral point of the transformer (as at G in Fig. 7),

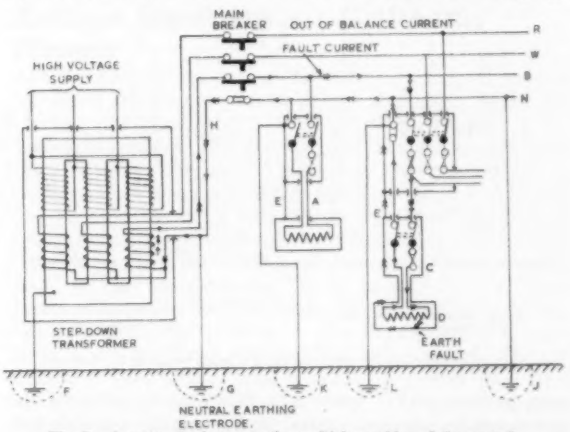


Fig. 7.—A system having protective multiple earthing of the neutral

to which is bonded the metal sheathing and any metallic armouring of the distributing mains (H) of the system. These electrodes shall be placed so that their resistance areas are distinct, to minimize risk of leakage from the higher voltage side of the supply transformer. However, it is not essential for the neutral point of the transformer to be earthed if the system includes two or more distributing mains having one or more connexions to earth.

At each distributing main the neutral conductor shall be connected to earth electrodes, or to the metal pipes of one or more water-supply systems, at points at or near he end remote from the supply transformer of the main and of each branch thereof (as at J) and at such other points as will ensure that the overall resistance to earth of the neutral conductor (a) does not anywhere exceed 10 ohm and (b) is low enough to ensure that the protective devices on the high-voltage side of the supply transformer will operate in the event of breakdown between the primary and secondary windings (although the time allowed for the operation of these devices is not specified).

An earth-continuity conductor, or conductors, (as at E in Fig. 7) shall be connected to the neutral conductor of the supply system, at the supply terminal for the

premises, from all metalwork enclosing, supporting or in proximity to the consumer's installation (other than metalwork designed to serve as a conductor or forming part of a telegraphic, telephonic or signalling circuit). Throughout the distributing mains and service lines the neutral conductor at all points must be of the same material as, and have a cross-sectional area equal to or exceeding that of the phase conductor at that point. The consumer's earth continuity conductor E shall have a resistance not exceeding $\frac{1}{2}$ ohm when tested by a current of not less than 10 amp for not less than 5 min.

Where P.M.E. is employed the I.E.E. Regulations state that it is desirable for the earthing lead at or near the consumers' terminals to be connected to an effective earth electrode system (as at K and L in Fig. 7).

The P.M.E. system is not accepted in some countries, and in some others the resistance to earth of the neutral conductor must be maintained at much less than 10 ohm. This system is permitted by U.S.A. Regulations, in

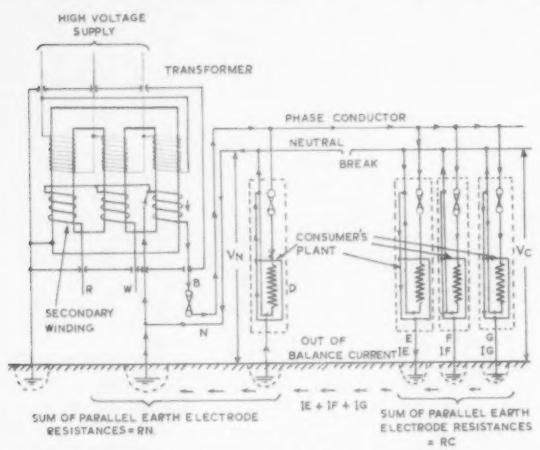


Fig. 8.—Conditions in P.M.E. system if a break occurs in the neutral

conjunction with a specified connexion to earth of the consumer's exposed metalwork, which should not exceed 25 ohm. However, over there, residential consumers are usually fed from a three-wire system with earthed neutral point, and only 120 volts between each phase conductor and earth as compared with our standard of 240 volts. Also most rural areas have a piped water supply to provide a low-resistance earthing connexion for the consumer.

Path of earth-fault current

As will be seen from Fig. 7, earth-fault current passes through the consumer's earth continuity conductor E and returns to the neutral point of the supply through the neutral conductor. This fault current (indicated by the double arrows) and the out-of-balance load current, if any, (indicated by the single arrows) pass through the consumer's excess-current devices so that the current will be cut off if it reaches a dangerously high value. The normal voltage existing between the exposed metalwork and earth will be the volt drop on the neutral conductor to the neutral point of the system, this being equal to the product of the impedance of the neutral conductor between these two points and the out-of-balance current and earth-fault current (if any) flowing between these points.

In the event of an earth fault on an appliance which had its casing earthed but not connected to the neutral of a P.M.E. system, the earth-fault current (I amp) would return to the neutral point of the system through the earth electrodes provided for the neutral. Unless, or until, the fault current was cut off by the consumer's protective devices the neutral, and exposed metalwork bonded to it, would be at a certain voltage to earth, equal to the product of the earth-fault current I and the impedance between the neutral conductor and earth. Dangerous conditions might arise if the latter impedance had a high value and, for this reason, the exposed metalwork of *all* apparatus used on a P.M.E. system should be bonded to the neutral.

Effect of interruption of the neutral conductor

The P.M.E. system appears to offer no advantages, other than the saving of one conductor, which are not possessed by using a separate earth return conductor from the exposed metal to the earthed neutral point. It has the disadvantage that, in the event of interruption

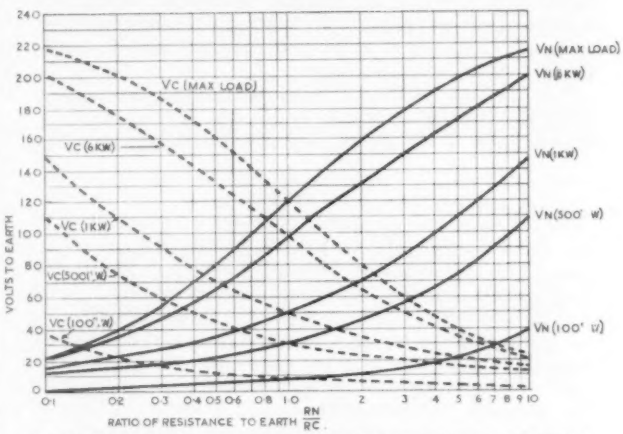
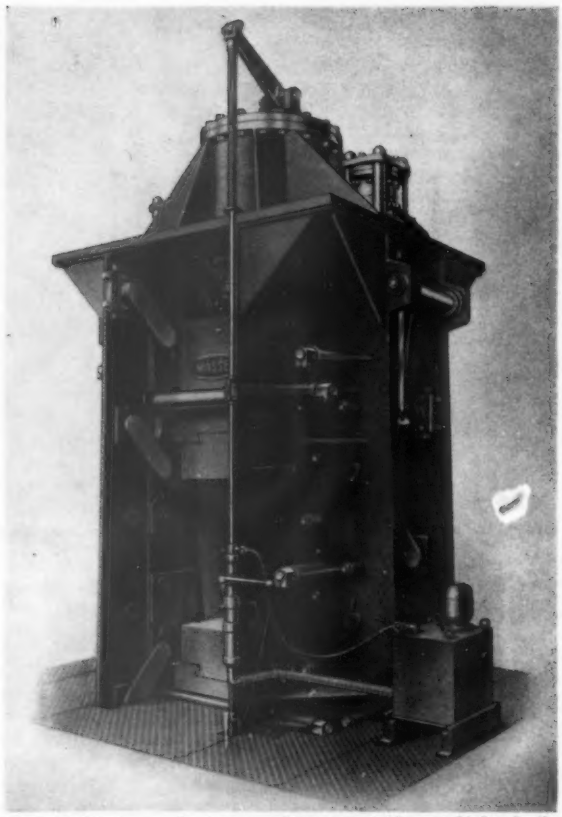


Fig. 9.—Effect of load current and earthing resistances on voltages to earth on 240 volt protective multiple earthing system having an open circuit in neutral

of the neutral conductor as indicated in Fig. 8, the out-of-balance load currents (if any) will return to the neutral point through the earth and earthing electrodes. If the earth electrode of a consumer D happened to have a fairly low resistance an appreciable part of this current might pass through the earthing system of this consumer, as indicated.

In Fig. 8 three consumers E, F and G are shown on the remote side of a broken neutral conductor of a system operating on a phase-to-neutral voltage of 240, the out-of-balance current I_o of these consumers being equal to $I_E+I_F+I_G$ amp, or W_o Watts. If the total resistance between the earth and neutral on the remote side of the break is R_c ohm, a voltage V_c, equal to $I_o \times R_c$, will then exist between earth and consumers' exposed metal bonded to that part of the neutral. If the total resistance between earth and the neutral on the transformer side of the break is R_N ohm the consumers' exposed metal bonded to this part of the neutral will then be at V_N volts to earth, equal to $I_o \times R_N$.

As will be seen from Fig. 9, the ratio of the voltages V_N and V_c depends on the ratio R_N/R_c, and both voltages depend on the out-of-balance current I_o, or out-of-balance load W_o Watts, of the apparatus on the remote side of the break from the transformer. There is thus a potentially serious risk of shock in the event of interruption of the neutral conductor, even when the system is completely free from any earth fault.



The counterblow hammer has two opposed tups connected by a steel belt and pulley system. This new Massey design is notable for its compensating gear

New Counterblow Forging Hammer

In recent years there has been a considerable revival of interest among drop forgers in the Massey Counterblow hammer, a machine which was originally designed 30 years ago and which has recently been completely redesigned by the makers, B. & S. Massey Limited, Openshaw, Manchester, to meet the severe working conditions of modern drop forging practice.

The Counterblow hammer employs two vertically opposed tups, the lower tup rising to meet the upper one as the blow is struck. There are obvious advantages in this arrangement on weak ground, where vibration must be avoided or where the transport of a heavy anvil would be difficult. In the Counterblow hammer all the energy is absorbed in the forging; there is no anvil loss as in the fixed-anvil type.

The redesigned Massey Counterblow hammers are made in a range of sizes number 6 to 40, the numbers indicating the blow energy in units of 1,000 metre-kilograms (43,500 ft lb to 290,000 ft lb). They normally operate on air (preferably hot) at a pressure of 6 to 7 atmospheres, though steam of the same pressure can be used where it is desired to use an existing supply.

As will be seen from the accompanying illustration, the entablature of the machine is of heavy welded steel construction. The cylinder is a steel casting and the tups are one-piece alloy steel castings with dovetailed recesses to take the dies.

Control is by Massey expansion valve gear which economizes in air or steam and gives instant control over stroke, and by hydraulic servo gear which minimizes hand or foot effort (hand operation is normal but a foot pedal can be added).

A unique feature of the new design is a patented compensating gear for the two belt couplings of the tup operating gear. The motion of the lower tup is transmitted from the upper tup by two steel belts passing over pulleys, special lightweight belt steel connexions, rubber shock absorbers, and spherically-seated alloy steel adjusting bolts. The two pulleys are kept at equal loading by hydraulically connected compensating cells filled with a stable fluid of silicone base. This compensating device ensures equal belt tensions at all times and safeguards both tup and belt. An indicator shows at a glance the state of adjustment.

Lubrication is by motor driven, automatic multi-feed pump electrically interlocked with the motor of the servo gear, thus ensuring that lubrication commences before the hammer is operated, and that the hammer cannot be worked should the lubricator motor fail.

Large Hydraulic Hobbing Press

A 5,000 ton hobbing press has recently been completed by The Hydraulic Engineering Company Limited, Chester, for the largest drop forging organization in the United Kingdom. The hobbing process, which has long been in use in the plastics industry, has only comparatively recently been adopted by the drop forging industry, but is now arousing interest as a means of forming relatively simple moulds much more quickly and cheaply than the normal die sinking process. Dies for producing such things as spanners, small hand tools, rocking levers and small crankshafts are being made by hobbing.

In the hobbing process, a die or mould is formed from a master die of special heat treated steel. The die is forced very slowly into a blank of normalized steel until the required depth is reached. The mould is then finished by machining, heat treatment and a final grinding or polishing operation. The speed of penetration must be as slow as possible to avoid splitting the blank. Speeds as low as 0·01 in. per min can be obtained by pump selection and a flow control valve.

To increase its versatility and utilization, the press is so designed that it can also be used for hot forging, or cold flow forging, at a reduced tonnage and a higher ram speed.

New Rawlplug Two-speed Drill

A new, all-purpose, two-speed Rawlplug electric drill obviates the need to maintain one tool for slow speed masonry drilling. The lower speed of 420 rpm is for fast penetration of masonry with a Durium drill. The higher speed, of 1200 rpm, is suitable for all normal drilling work and the changeover is effected by a simple push-pull button.

The drill has a pistol grip, a trigger operated motor switch and a quick release push button to lock the switch for continuous drilling.

The chuck will take all sizes of drill up to $\frac{5}{16}$ in. dia and operates on a self-tightening system which while providing a rigid grip is quickly opened by hand.

The R.P.2. drill costs £15.5.0 complete with 9 ft of 3-core cable.

Grinding Uranium Oxide Slugs

The grinding of certain of the materials used in the production of nuclear energy, apart altogether from any question of radioactivity, necessitates certain precautions on account of the toxic character of the dust produced. The more usual methods of dust extraction cannot be 100% effective when applied to a centreless grinder due to the conditions imposed by the design of the machine, but the accompanying photograph shows one of the latest Wickman-Scrivener Model-O centreless grinding machines with special equipment designed by Arthur Scrivener Limited, of Tyburn Road, Birmingham, for this new and rapidly developing field of work. The machine when photographed was set up for grinding uranium oxide slugs, and it will be noticed that the equipment includes a transparent plastics hood with doors to give access to the machine controls when this is necessary, the work being fed to the grinding throat of the machine from the small vibratory hopper to be seen in the foreground.

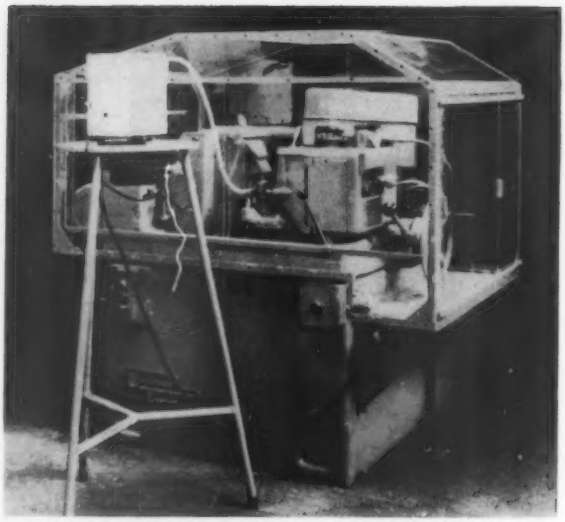
The machine shown has a grinding wheel 12 in. dia and a control wheel 7 in. dia, both 3 in. wide, the main driving motor being 5 hp. On small cylindrical work of this description, it is capable of a production of several thousand pieces per hour.

Nuclear Reactor Trainer

A special purpose 200-amplifier computer capable of setting up an electronic analogue of a complete nuclear power station is to be used by Calder Hall as a trainer for reactor operators. It is being built by Short Brothers & Harland Limited and will include a representation of the steam raising and electrical generation sections of the power station in order to demonstrate their various effects on the reactor. A mock reactor control desk is being designed by the Research and Development Branch of the Authority, and for this the simulator will provide the following information: average flux, coolant flow, the core inlet gas temperature and the three zone outlet gas temperatures, H.P. and L.P. steam pressures and flows, control rod positions, turbine speeds, and power output. Overall component error will not exceed one part in one thousand.

The equipment will be housed in five standard Post Office type racks and a subsidiary console, thus following the design trends initiated in the new high accuracy SIMLAC computer recently announced by the Belfast company. The nucleonic core heat transfer simulation will be divided into three zones, each occupying one standard rack. The simulator has been so designed that any further splitting of the core can easily be covered by adding to the number of standard racks. The heat exchange and turbo-alternator simulators are also grouped together and mounted in a twin-rack unit.

As many as possible of the facilities devised for the SIMLAC computers are being incorporated in the simulator. These include push-button selection of potentiometer values and a clutter-free removable patch panel based on the SIMLAC design. The control simulation is accommodated in the console so that the various control figurations may be changed quickly and easily. The console also acts as a junction box for the interconnexion of the three reactor zones and the heat exchanger turbo-alternator group. The introduction of additional reactor zones will require only the laying of extra cable to the console; it will be unnecessary to touch the original equipment.



This machine is grinding slugs of uranium oxide and the transparent plastics hood is to retain toxic dust which is extracted by special equipment

Borated Graphite Used in Dounreay Reactor

For the first time special borated graphite blocks were used by the United Kingdom Atomic Energy Authority in the assembly of the shield which surrounds the fast breeder reactor vessel at their experimental station at Dounreay. The blocks were made and machined by The Morgan Crucible Company Limited at their works at Norton, near Worcester. This factory is not engaged in the production of nuclear pure material and was therefore chosen as one suitable for handling large quantities of boron compounds. The purpose of the borated graphite is to slow down fast neutrons and then absorb them in the shortest possible distance, thus providing a safety screen.

Most of the borated graphite contained 0·3% Boron, but some contained 5%, in both cases very uniformly distributed throughout the graphite. The blocks themselves were machined to 500 different patterns. Some of the patterns were so intricate that wooden dummies had first to be made to ensure that it was practicable to machine them in graphite. As a final check, the layers of finished graphite blocks were assembled at Norton into their complicated form of eccentric circles.

The blocks, painted with distinguishing coloured bands to avoid any risk of confusion with nuclear pure material, were then packed into cartons for the journey. Transport to Dounreay was by heavy lorry which made one round trip of 1,500 miles per week, taking the whole dry season of one year, some eight months in all.

Electronic Image Intensifier for Viewing Nuclear Particles

An electronic tube that can "see" a splitting atom or the faintest star has been developed by the electronic tube division of the Westinghouse Electric International Company, U.S.A. The new tube is an advanced type of image intensifier which amplifies the light entering at one end to produce an image as much as 3,000 times brighter on the fluorescent screen at the opposite end.

The most important use of the new device is expected to be in the nuclear field where it will permit photo-

graphic records of atomic particle reactions. Two University of Michigan physicists, Martin L. Perl and Lawrence W. Jones, have already used the tube in a luminescent chamber system to produce what are believed to be the first photographs, outside the U.S.S.R., of light from the path of a single atomic particle.

Pictures never before possible can be taken with the tube of the minute light scintillations that occur when certain materials are struck by nuclear particles produced by "atom smashers". The nature of these fleeting scintillations provides information on the nuclear reaction being observed. In astronomy, the image tube can further intensify the output of telescopes when viewing very faint stars, or it could be used in satellites to obtain pictures of far distant stars and galaxies.

The device can reintensify its own output simply by leading the light output back through the tube with a system of mirrors. It is said that four of the tubes feeding into each other with lenses would be able to produce a picture of a single photoelectron.

Fuel Element Laboratory for Windscale

The most advanced irradiated fuel element cave laboratory in the world is being installed in the blower houses of No. 2 reactor of the Windscale works, Cumberland, which closed down as a safety measure after the incident in 1957. The laboratory is designed to handle several thousand fuel elements a year from the nuclear power stations as well as from experimental reactors.

The five major requirements which the facility has to meet are: (1) to permit superficial examination and radiography, (2) provide apparatus for sorting out failed from sound elements, (3) provide a means of taking the fuel rods out of the can in which they are contained without distorting either, (4) provide apparatus for dimensional and density measurements of the fuel rod, (5) enable sections of the can and fuel rod to be produced for passing to the metallurgical laboratory.

All the work done on the elements from the time they arrive, will be by remote control machinery specially designed by Irwin and Partners and tested by them at their London headquarters.

Gammagraph—a Check on Nuclear Radiation

Looking like a white-painted bomb pointing skyward, 30 in. high and 9 in. dia, the Gammagraph, Model 65A, developed and manufactured by Electronic Instruments Limited, Richmond, Surrey, makes accurate and continuous measurement of gamma radiation in or out of doors. It will enable meteorological stations and local authorities to record gamma or background radiation as simply as they have for decades recorded temperature, barometric pressure, rainfall and hours of sunshine. It consists basically of an ionization chamber, 18 in. long, containing a special mixture of gases under pressure, mounted vertically on a hermetically-sealed case containing the electrometer circuits and a clockwork-driven recorder. The recorder trace can be observed through a glass panel without opening the instrument and all controls are mounted internally to avoid unauthorized interference. Power for one month's continuous operation is provided by a conventional 12 volt, 40 ampere-hour car battery. Except for one electrometer valve, the circuit is fully transistorized. Zero stability is better than 2% of full scale on any range for one month and is largely independent of battery voltage and ambient temperature.

The Gammagraph's high performance is due to a new transistorized electrometer, which will drive a rugged 1 mA recorder to full scale with currents as low as 10^{-12} amps. Linearity and stability are assured by high overall feedback, yet the power consumption of the complete instrument is less than 0·5 W.

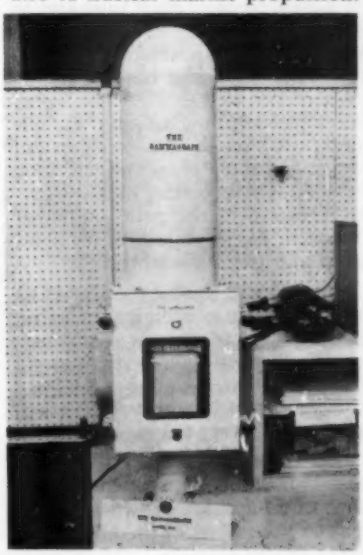
TRIGA Reactors

The reactors covered by the agreement whereby Vickers-Armstrongs will manufacture and sell General Dynamics Corporation's General Atomics Division TRIGA atomic reactors in the United Kingdom are the standard Mark I (below ground) and Mark II (above ground) up to a maximum steady state operating level of 100 kW. They are designed for training, research and isotope production, as well as for medical and industrial applications, and have received world-wide acceptance.

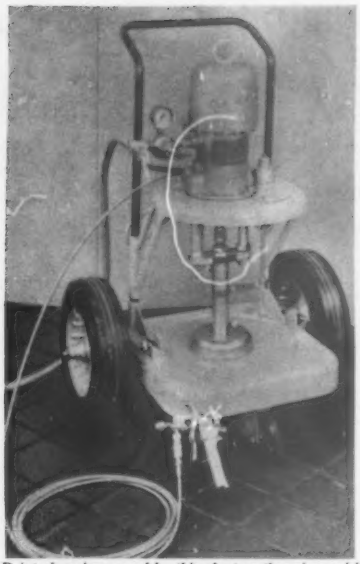
The outstanding feature of these versatile reactors is the extraordinary degree of inherent safety because of the homogeneous fuel-moderator elements of uranium-zirconium hydride. The homogeneous mixture of fuel and moderator provides a prompt negative temperature coefficient which acts as an automatic self-regulating mechanism, thus preventing the core from overheating or otherwise damaging itself in the event of a power excursion.

English Electric Organic Reactor

The English Electric Company Limited who have hitherto devoted almost the entire resources of their Atomic Power Division to the development of the gas-cooled graphite-moderated reactor system, have now taken up the organic liquid cooled system by a collaboration agreement with North American Aviation Inc. Atomics International have carried out extensive research and development, much of it in association with the United States Atomic Energy Commission, for some years on the organic liquid cooled reactor, which shows considerable promise as a potential low-cost system particularly applicable to smaller nuclear power stations and also to nuclear marine propulsion.



The Gammagraph is the first instrument developed to measure continuously the fall-out of gamma radiation indoors or out of doors, such as in the vicinity of a nuclear power station. It is powered by an ordinary car battery



Paint alone is sprayed by this plant so there is no risk of overspraying. The hydraulic pressure is derived from air-line supply via air motor and pump

Airless Paint Spraying

The Hydra-Spray airless paint spraying system operates by use of high hydrostatic pressures, varying from 1,000 to 3,000 psi. A reciprocating, double acting air motor, is coupled by a connecting rod to a reciprocating double acting pump which multiplies the fluid pressure to twenty times the air pressure admitted to the air motor, e.g., with an incoming air line pressure of 80 psi the pump develops 1,600 psi fluid pressure.

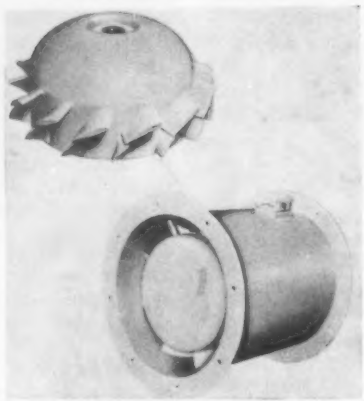
This high pressure is confined to the pump, to the Teflon tube and to the spray gun. The Teflon tube is reinforced with an external stainless steel wire braid and has a bursting pressure of 10,000 psi. The spray gun is fitted with a tungsten carbide nozzle to resist the erosion of abrasive paint when under high pressure. There is not, at any time, any pressure in the paint container (removed in photograph to show pump and paint agitator).

Since Hydra-Spray does not use compressed air to atomize the paint, virtually all over-spray is eliminated; so effective is this reduction in over-spray that a saving is claimed of approximately three gallons of paint out of every ten gallons used.

The Hydra-Spray is one of the most important items in the Graco range of equipment of which Alfred Bullows & Sons Limited, Long Street, Walsall, Staffs, are the sole U.K. distributors.

Slotted Blade Fans

Collaboration between the General Dynamics' Electric Boat Division, Groton, Connecticut, and Keith Blackman Limited, fan equipment manufacturers. London N17, has resulted in agreements being reached to produce in Britain patented designs of axial fans with special slotted blade formation.



Top, the slotted blade axial fan impeller. Bottom, the Keith Blackman Ax-Slot fan

The slotted blade provides the means of boundary layer control. This offers the choice of higher efficiency or higher pressure ratios, or a combination of both. Boundary layer control also ensures that with higher pressure ratios and minimum losses due to turbulence and blade friction, the fan size, running speed, airborne noise and structure-borne vibration are all reduced.

These revolutionary developments in design emanate from extensive research programmes undertaken by both companies. One application in the U.S.A. has been the introduction of slotted blade axial fans, with their emphasis on quietness, into all the nuclear-powered submarines (in the interests of maintaining silence to escape detection) as built by the General Dynamics' Electric Boat Division.

Many other industrial, general marine and aeronautical applications present themselves for this new fan type which is to be marketed in Britain under the trade name "Ax-Slot".

New Enamel Finish

An entirely new stoving enamel finish which can be applied directly to metal surfaces without priming has been introduced by Lewis Berger (Great Britain) Limited under the name "Bergercron".

The new family of acrylic resins which forms the basis of Bergercron finishes permits of broad modifications in solubility and film characteristics. Application can be made by all normal methods—spray, dip, roller coat, flow coating. Physical properties can be varied to provide utmost corrosion resistance and durability or extreme flexibility such as required in the fabricating operations of the container industry.

Adjustable Precision Dashpot

The Kinetrol precision dashpot, which has already found numerous applications in the fixed-rate form, is now available in an adjustable-rate version. Any numerical value of damping within a 10:1 range may be obtained by setting the calibrated knob to the desired rate. The characteristics of this silicone-filled damper are the absence of friction, thus ensuring purely viscous resistance, and the elimination of leakage and backlash. This is because the shaft seal is a flexible rubber sleeve bonded to both the cover and the shaft, and there is no surface at which sliding occurs. The use of diecast components has permitted a large cut in the cost. Rates available are 2·0–2000 lb-in./rad/sec. There is also a differential rate model which gives a large resistance in one direction only. The dashpot is made by Kinetrol Limited, Trading Estate, Farnham, Surrey.

The adjustable version of the Kinetrol dashpot has a calibrated knob for setting within a 10:1 range

New Heat Transfer Medium

A new heat transfer medium has been added to the range of phenol derivatives made by the Heavy Organic Chemicals Division of I.C.I. Named "Thermex" (trade mark of Imperial Chemical Industries Limited) it is a eutectic mixture of diphenyl oxide and diphenyl in the respective proportions by weight of 73·5% and 26·5%, and is the first heat transfer medium of this type to be manufactured commercially in Britain.

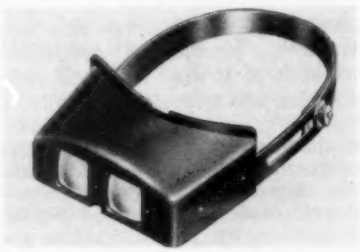
A highly desirable combination of physical properties makes Thermex particularly suitable for liquid-phase and vapour-phase heating and cooling in a variety of industrial processes. It has a high boiling point (255° C) and low freezing point (12° C), and excellent thermal stability over long periods at temperatures up to 400° C. It has high heat transfer coefficients, particularly in the vapour phase; further, it is non-corrosive and presents a negligible fire risk.

At high temperatures, Thermex operates at low working pressures. For instance, at 250° C, when steam is at a gauge pressure of 565 psi, Thermex is still in the liquid phase and at atmospheric pressure. At 350° C, the gauge pressure of steam is 2385 psi whilst the comparable pressure of Thermex is only 80 psi. Furthermore, in vapour-phase heating, very accurate temperature control may be achieved simply by regulating the pressure. A single Thermex boiler may be used simultaneously for several different consuming points by adjusting the pressure at each point to give the desired temperature.

Typical examples of industrial processes in which Thermex can be used are: the melting and spinning of synthetic fibres; the distillation and processing of fats, vegetable oils, petroleum fractions, and other high-boiling products; the concentration of sulphuric acid and caustic soda solutions; the processing of plastics and rubber products by extrusion and moulding techniques; and the manufacture of paints and varnishes.

Headband Magnifier

In these days of intricate close work and the examination of minute detail, any magnifying unit that can be used without personal fatigue whilst leaving both hands free, is particularly welcome. Ellis Optical Company, Mayday Road, Thornton Heath, Surrey, have designed and produced a headband magnifier that makes examination of minute detail most easy since it provides magnification with good stereoscopic effect. The lenses are accurately ground with the requisite prismatic effect to prevent eyestrain, even when worn continuously. The focal distance is approximately 8 in., the field of view large, with a magnification of 2¼ times.

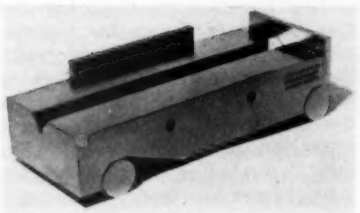


The Ellis headband magnifier. It has a magnification of 2¼ times, may be worn over spectacles and the lower side of the hood being open allows unrestricted downward vision

Constructed of a strong, light weight plastic material it can be worn for long periods without discomfort. The hood, by extending over the top and sides, shields the eyes from glare, whilst the object viewed may be under the most brilliant illumination. The lower side is open, allowing unrestricted downward vision, an advantage at once apparent to those using small tools, or wishing to make notes, both hands being free for this purpose. Spectacle wearers can use this magnifier without removing their glasses. The price is 36/-.

Stripcoat for Spray Booths

Unless spray booths have side water walls as well as the normal rear water wall, it is virtually impossible to keep overspray from building up where is is not wanted. Even with semi-automatic spraying when the amount of paint or sprayed material is carefully regulated to prevent wastage, some paint will adhere to the inside of the booth. Aerostyle Limited, Sunbeam Road, North Acton, London NW10, now market a rubbery material called "Stripcoat" which can be sprayed or brushed on to the sheet metal work, laid on slightly more thickly than a normal coat of paint. When the booth is cleaned, all that is necessary is to scrape up one corner and strip off the coat which comes away in one piece with the overspray paint from many hours of booth operation, in a matter of a few minutes.



SINE TABLE.—This 5 in. sine table is made by Grey & Rushton (Precision Tools) Limited, Coventry, from hardened tool steel, ground and lapped to British Standard. The ground Vee is parallel to the sides and end and side stops are provided; the side stop being reversible. The table dimensions are 6 in. × 2½ in.

Aluminium-coated Sheet Steel

A new material, mild steel sheet hot dip coated with aluminium and already in widespread use in the U.S.A., is now in production in Britain in a limited range of sizes and gauges by Coated Metals Limited, Palmerston House, Bishopsgate, London EC2. "Aludip" as it is called, has the property, unique for a low cost material, of very good resistance to heat and to corrosion, especially in sulphurous atmospheres, and can therefore be used for the fabrication of heat exchangers, silencers, exhaust systems. It can be worked up by the usual sheet metal working processes, including seam and spot welding. The surface is reasonably smooth and attractive and needs no further surface treatment, other than decorative if required.

Flexible High-speed Steel Hacksaw Blades

A new hacksaw blade in 10 in. and 12 in. × ½ in. sizes has been introduced by J. Stead & Co. Limited, Manor Works, Cricket Inn Road, Sheffield 2. Named the "Steadfast" it is of high-speed steel, but only the teeth are hardened, thus the blade is very flexible and is free from the frequent breakage which occurs with fully-hardened blades in the hands of unskilled labour. The prices of the new blades are the same as for other high-speed steel hacksaw blades.

Factory Seats

What is said to be the cheapest factory seat in the world is being marketed by General Trade Equipment Limited, Seymour Place, London W1. It is made in six different heights at 2 in. intervals from 20 in. to 30 in. of light angle and steel strip with vulcanized fibre back and seat. The non-scratch feet can, if required, be screwed to the floor.

books

Production Tooling Equipment. By S. A. J. Parsons. London, 1960; Cleaver-Hume Press Limited. 28/- net (by post 29/1). 328 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

This book has the distinction of being officially approved, in the subject of tool design, for the Associate Membership Examination of the Institution of Production Engineers. It covers jigs and fixtures, cutting tools, tool layout, and gauges, and deals also with economic aspects of tooling up and with the general topics and fundamentals relevant to the subject.

In the chapters on jigs and fixtures a full range of applications is covered—drilling, milling, turning, grinding, broaching—and details given regarding locating and clamping, indexing, and the use of pneumatic and hydraulic devices. Cutting tools are covered with similar completeness—materials, single-point tools, multi-edged rotary tools, form tools, thread-producing tools, broaches—and there are, notably, sections on micro-drilling, the design of high rake milling cutters, and the design of tools for surface broaching. The discussion of tool layout covers capstan, turret and auto-lathes, and single-spindle and multi-spindle automatics.

The treatment is detailed and the book is well illustrated. It is clearly a useful book to have for reference in practical work; its additional purpose as a text for study is enhanced by an appendix containing typical examination questions.

Applied Heat for Engineers. By J-B. O. Sneeden. Glasgow, 1959; Blackie & Son Limited. 25/- net (by post 26/6). 380 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

Between theoretical engineering thermodynamics and the description of machinery there is a practical field for the study of the application of principles, the making of calculations and the discussion of efficiency and performance. This field is receiving a good deal of attention from technical authors and there are some good books devoted to it, and this is certainly one of them. The man who is more at ease with the machinery than the purely scientific side, and the scientifically inclined who wants an introduction to the practical view will both be satisfied with it. The author deals with real things, and introduces his calculations and explanation of principles as and when they become useful. He covers diesel engines, steam power plant, blowers and compressors, the gas turbine, and refrigeration plant. Also treated are the Carnot, constant volume, constant pressure and diesel cycles, the thermodynamic properties of gases and vapours, fuels and combustion, the transmission of heat, expansion, and the various fundamentals on which any study of the subject must necessarily be based.

Rubber to Metal Bonding. By S. Buchan. London, 1959; Crosby Lockwood & Son Limited. 42/- net (by post 43/2). 300 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

Although there is now quite a wide choice of agents for bonding rubber to metal, the original process based on brass plating is still the most used. It involves the use of plating solutions and plant, metal alloys, compounded rubber whether natural or synthetic, moulds and moulding plant, and specialized methods of testing. All these technologies are treated thoroughly in this book, always strictly in relation to the one object, and to the extent of the first 13 chapters. Then follow five chapters on bonding agents—thermoplastic, halogenated rubber derivatives, the polyisocyanates and others, and on the bonding of vulcanized rubbers. An important chapter is that on the design of rubber bonded components—like some other processes a little thought at the design stage, tempered by some knowledge of the bonding processes and the materials employed (such as the book provides) can make all the difference in the success of the product.

Notes on Pipework Design. By A. A. Smith. 1959; The Association of Engineering and Shipbuilding Draughtsmen, Richmond, Surrey. 3/6 net (by post 3/10). 75 pp. $5\frac{1}{2} \times 8$ in.

A great deal of ground is covered concisely in this pamphlet which certainly provides an admirable introduction to an important subject and one which has not yet acquired the literature it deserves. Piping is too often regarded as a minor adjunct to the plant or machinery of which it forms a part, whereas in truth it provides the veins and arteries of a system and should be accorded consideration commensurate with its importance. There is all the information here for sizing pipe for different fluids, laying it out properly, providing fittings and making provision for working requirements. There is a lot of practical detail of the kind that only comes from experience and this alone makes the pamphlet an advanced starting point for anyone coming fresh to the subject.

Hot Dip Galvanizing. London, 1959; Zinc Development Association. 60/- net (by post 61/6). 355 pp. $6 \times 9\frac{1}{2}$ in.

This book contains the edited proceedings of the Fifth International Conference on hot dip galvanizing held in June, 1958, in Holland and Belgium. It gives a great amount of technical information and data, all of it presented, due to the editing, in a systematic and useful form. Various aspects of the process are treated and also strip and wire galvanizing. There is a useful section on paint on galvanized steel and another on materials handling. The philosophical aspect is treated in a discussion of human progress through technical progress and the contribution made by galvanizing.

The Geometry of Conical Pipes, Bends and Joints. By W. Sellar. 1959; The Association of Engineering and Shipbuilding Draughtsmen, Richmond, Surrey. 3/6 net (by post 3/10). 50 pp. $5\frac{1}{2} \times 8$ in.

The economy of making sheet metal pipes and fittings is closely related to design, and as it is possible to design for the minimum use of special tools and formers the relationship is particularly important when small quantities have to be made. In this pamphlet the author enlarges on a simple principle to cover the whole of the geometry of pipework including enlargers and reducer angled branches, bends, tees, etc.

An Introduction to Product Design and Tooling. By S. C. David. 1959; The Association of Engineering and Shipbuilding Draughtsmen, Richmond, Surrey. 3/6 net (by post 3/10). 56 pp. $5\frac{1}{2} \times 8$ in.

The author of this pamphlet writes for the young beginner and neglects no point, however small, which is required on his first being introduced to the art of the jig and tool drawing office. The methods he describes are those of the modern mass producing factory using the best equipment. Examples are given of standardized procedures.

Plant Engineering Handbook. Edited by William Staniar. New York, 1959, McGraw-Hill Book Company Inc., London; McGraw-Hill Publishing Company Limited. £9 2s. 0d. net. (by post £9 4s. 6d.). 2,482 pp. 6 × 9 in.

The price of this book works out at about a penny a page, and that is throwing in the good binding for nothing. This may seem to be an odd way of introducing a book, but since the price is out of the usual run of technical books it seems worth while getting the perspective right: it is good value.

Some of the 42 sections are peculiarly the province of the plant engineer, others he shares with other kinds of engineer, but as treated in this handbook the subject is always as the plant engineer sees it and the tools offered are those he needs for his particular work. The scope is comprehensive and ranges from practical management through all kinds of power generating and using plant—steam, gas, air, electric and fluid—to details like packings, bearings, rubber hose, carbon and graphite. Engineered plant maintenance, water treatment, process instrumentation and process air conditioning are examples of special plant engineering subjects treated, and among essential auxiliaries are rated industrial painting, foundations, heating, welding and brazing, lubrication and industrial glass. There are numerous other topics like vibration, graphical mathematics, industrial electronics and heat transfer; and also essentials to a modern approach like materials handling, electrical speed control and automation.

This survey does not nearly represent the coverage offered in this voluminous yet concise and amply illustrated text. Suffice it to add that this is a second edition which appears as a result of the success which attended the first.

Locomotive Tests.—Bulletin No. 20 of the British Transport Commission deals with performance and efficiency tests carried out on the British Railways modified Merchant Navy Class 3-cyl. 4-6-2 express passenger steam locomotive No. 35020. The engine as modified has separate valve gear on each of its three cylinders and the tests described establish the principal relations involved in the conversion of heat into useful mechanical work and the principal factors involved in this conversion that are of especial value in design problems. The greater part of the bulletin is given over to the presentation of the results of the tests in tabular and graphical form. Copies can be obtained from the Chief Publicity Officer, British Transport Commission, Room 268, 222 Marylebone Road, London NW1. Price 10/-.

Education and Training in Chemical Engineering.—A new pamphlet published by The Institution of Chemical Engineers contains a unique collection of information on scholarships, courses and apprenticeship training schemes in chemical engineering. Designed primarily for the benefit of school boys and girls who have shown interest in a career in chemical engineering, the new pamphlet is supplementary to the more philosophical pamphlet "Chemical Engineering: A Career". It will also be of interest to many chemical engineers and others in industry who have a professional interest in matters relating to the education and training of chemical engineers. A copy will be sent free of charge to any person on written application to the Institution, 16 Belgrave Square, London SW1.

European Free Trade Association.—The new F.B.I. booklet "European Free Trade Association" gives in brief the historical background leading up to the signing of the Outer Seven Convention and provides a commentary of the terms of the Convention itself. The objects of the Convention are set out and then the booklet deals with the sections of the Convention covering import duties, import quotas, definition of origin and deflexion of trade and the escape clauses included to safeguard members of the Outer Seven in the event of any deterioration in their balance of payments or difficulties experienced in any particular sector of industry. Appendices give the basic materials list, details of the special provision in the Convention for Portugal and a series of charts giving vital economic data on each of the member countries at a glance. The price of the booklet is 7/6 from the Federation of British Industries, 21 Tothill Street, London SW1.

ASTM References on Fatigue.—This list of references to articles published in 1958 dealing with fatigue of structures and materials is a continuation of a series started in 1950, and consists of 76 duplicated pages with 386 references. All nine reference volumes dating back to 1950 are available for $15. Copies of the book may be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. at $3.50 each.

Bibliography on Filing, Classification and Indexing Systems.—Available from the Engineering Societies Library, 29 West 39th Street, New York 18, N.Y. at $2, this 33 page bibliography is prepared for engineers and librarians concerned with organizing their own files or the files in the engineering offices or libraries where they work and relates to books, pamphlets and magazine articles on filing, classification and indexing, etc. There is a subject index as well as an introduction, in which selection and use of the systems are discussed.

New Standards

B.22 Bayonet Cap Lampholders of Moulded Insulating Material. Supplement No. 1 (1959) to B.S. 52:1952 (P.D 3559). Price 5/- net.

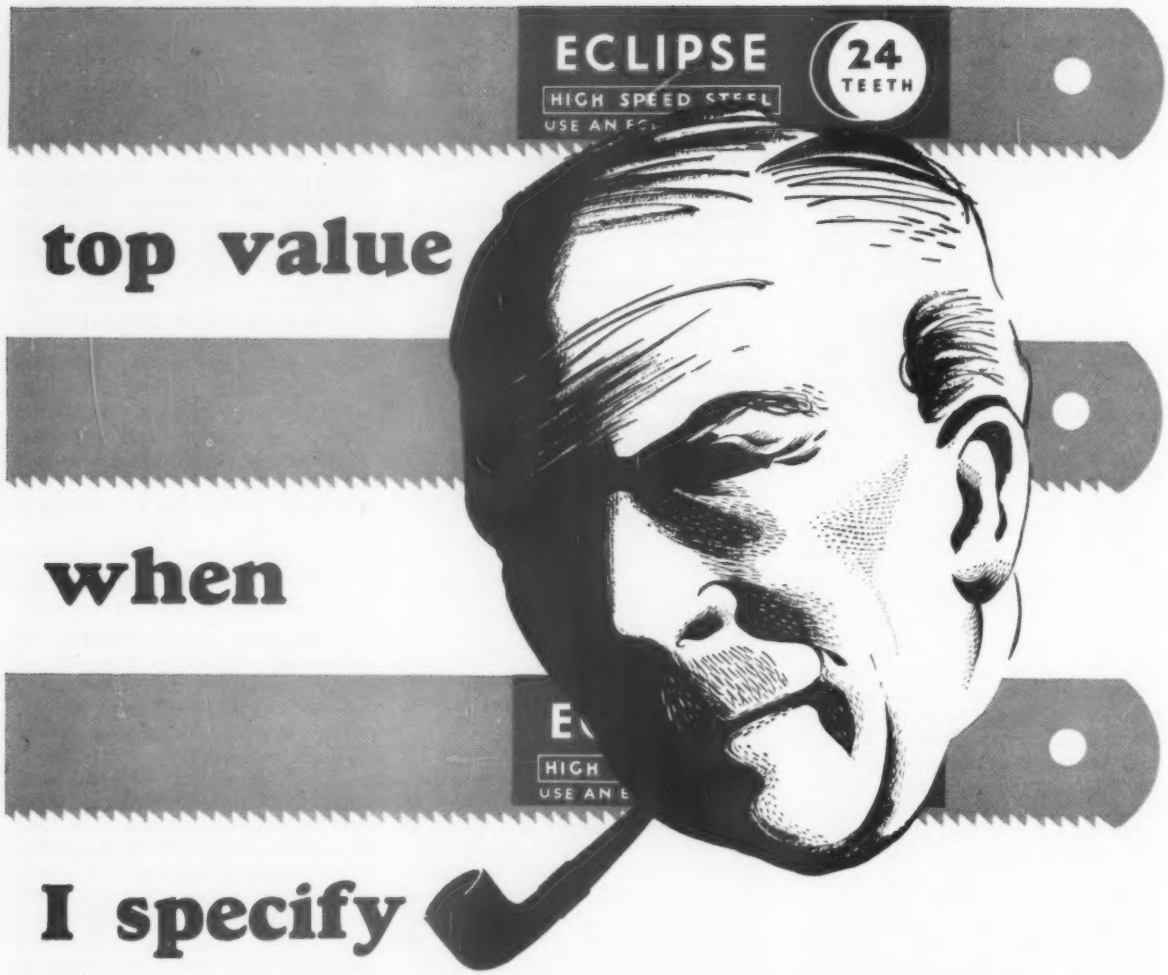
This supplement applies solely to B.22 bayonet cap lampholders made of insulating material and suitable for tungsten filament lamps used for general lighting service. One object is to ensure interchangeability of parts, particularly of the shade carrier rings. A protective shield can be used instead of a shade carrier ring when required. Moulded insulated lampholders are subject to some shrinkage as a result of heating during service, and this shrinkage is not constant with any one design: the dimensions and tolerances for screw threads now specified provide for variations in manufacture and for dimensional changes during the life of the shade carrier ring. Tests are included to ensure satisfactory quality of design and manufacture.

Electronic Valve Bases, Caps and Holders (B.S. 448: sections B5G/F and B7E/F). Price 2/- each net.

These new sections specify the base and bulb outline dimensions of the B5G/F and B7E/F sub-miniature valves with flexible connecting leads. Gauges for checking the lead spacing and the bulb outline dimensions are also specified.

British Standards Institution, 2 Park Street, London, W1

I buy



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24
TEETH
HIGH SPEED STEEL
USE AN ECLIPSE FRAME

Eclipse

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'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

UH36

BUSINESS & PROFESSIONAL

Personal

Mr. K. W. Sims has been appointed export promotion manager of C. C. Wakefield & Co. Limited, parent company of the Castrol Oil Group.

Mr. Alan J. Marles, B.Sc., A.C.G.I., A.M.I.Mech.E., has been appointed technical manager of Ransome & Marles Bearing Company Limited, Newark-on-Trent.

THE BRITISH IRON AND STEEL RESEARCH Association announces that **Mr. S. S. Carlisle, M.Sc., A.M.I.E.E.,** head of the physics department, has been appointed an assistant director. He will be especially concerned with the co-ordination of the Association's work on automation and information handling which is now a vital part of the research programme.

F. PERKINS LIMITED, Peterborough, announces that it has formed an overseas manufacturing operations division under the directorship of **Mr. K. E. Woollatt,** former director of administration.

Mr. O. D. Gwilliam has been appointed assistant general manager of Foster, Yates and Thom Limited, Blackburn.

BRITISH INSULATED CALLENDER'S CABLES Limited announce that **Mr. T. C. Johnston,** formerly general manager of Metropolitan Electric Cables and Construction Company Limited, has joined the company as regional manager (Eastern Region).

Mr. D. J. Clarkson and **Mr. R. J. Welsh** have resigned their directorships with the Glacier Metal Company Limited. **Mr. F. B. McPherson** has been appointed a director of The Genuine Thin Wall Bearing Company Limited (wholly-owned subsidiary of The Glacier Metal Company Limited).

Mr. F. W. Tomlinson, managing director of Pyrotenax Limited, **Mr. J. M. Willey,** director and general manager of Murex Welding Processes Limited, and **Mr. P. S. Bryant** of Murex Limited, have been appointed to the board of Murex Limited, Rainham. Mr. Tomlinson has also been appointed to the board of Murex Welding Processes Limited, Waltham Cross.

Mr. W. R. Dearden, A.M.I.Mech.E., has been appointed southern area manager for Highfield Gear & Engineering Co. Limited.

BAKER PERKINS announce that **Mr. F. Arnold Wilson,** has joined the company's foundry machinery department in a part-time capacity as foundry machinery adviser to their Bedewell Division, Hebburn-on-Tyne.

Mr. J. S. Bright, who joined C.A.V. Limited last year from F. Perkins (Canada) Limited, has been appointed service manager of the company where he will be responsible for control and co-ordination of all aspects of C.A.V. service at home and overseas. **Mr. C. W. Billington** continues as service manager for the U.K. and is responsible to Mr. Bright.

Mr. R. E. F. Sykes, A.M.I.W.M., has been appointed general manager of Griffin & George (Laboratory Construction) Limited. Mr. Sykes succeeds **Mr. A. E. Lambert,** who has retired from the company.

UNDER the direction of Mr. Ewen M'Ewen, director of engineering, Europe, **Dr. B. F. Willetts, Ph.D., M.Sc., A.M.I.Mech.E., M.I.Plant E.,** is now chief engineer, United Kingdom, of Massey-Ferguson. Two assistant chief engineers, **Mr. L. E. Summerfield** and **Mr. H. R. Jenner,** will be under Dr. Willetts.

SUFFOLK IRON FOUNDRY (1920) LIMITED, Stowmarket, announce the appointment of **Mr. W. E. A. Williams,** formerly the company's London and South East area representative, as sales manager. Two new representatives have also been appointed: **Mr. G. A. Edmunds,** who has taken over Mr. Williams' representation in London and the South East, and **Mr. S. E. Witherington,** who has been appointed as Birmingham area representative in the place of **Mr. E. Christie,** who has returned to headquarters at Stowmarket owing to ill-health.

CROFTS (ENGINEERS) LIMITED, Bradford, Yorks, announce the appointment of **Mr. G. W. Wells, Mr. D. R. Emery, Mr. A. W. Mills,** and **Mr. W. E. Kimbley** as technical sales representatives at the London office. **Mr. S. Wheatley** succeeds **Mr. C. R. Jones** (resigned) as Bradford Area manager, and **Mr. W. Green** has been appointed representative there.

Mr. C. B. Cornelius has been appointed works manager of A. J. Flatley Limited, Kingston Mill, Cobden Street, Salford, Lancs, responsible for all matters concerning production of dryers, washing machines, convector heaters, central heating equipment and other domestic appliances which are shortly to be in production.

Mr. J. L. Steane has joined the staff of the Bronx Engineering Company Limited, in the position of sales engineer. He has a wide experience of the equipment manufactured for the sheet and plate metalworking industries and will have special responsibilities for areas extending from the North Midlands to the North of England.

A.E.I. (RUGBY) LIMITED, formerly the British Thomson-Houston Company Limited, announce the appointment of **Mr. D. Edmundson, B.Sc., M.I.E.E.,** as general manager, Rugby works. This will enable **Mr. H. E. Cox,** who has been general manager since 1957, to devote his time to the duties of deputy director of manufacture.

Mr. G. P. Thompson, until recently manager of transformer factory at Rugby works, has been appointed manager—Manufacturing A.E.I. (Rugby) Limited.

Mr. Frank W. Townsend, M.B.E., manager of the model shop and test gear department of The Plessey Company Limited at Ilford retired recently after 28 years service with the company.

Mr. C. D. Wild has been appointed service manager at the Clay Cross branch of Bowmaker (Plant) Limited at Willenhall. Bowmaker (Plant) Limited also announces the appointment of **Mr. V. L. Mullowney, B.Sc., A.M.I.C.E.,** as their area manager for South Wales.

ORGANIZATIONAL changes announced by Mobil Oil Company include the appointment of **Mr. B. R. Fraser** as manager of a new manufacturing department to be located in the head office at Caxton House, Tothill Street, London SW1. **Mr. J. W. Bartholomew** succeeds Mr. Fraser, at Coryton, and **Mr. C. E. Bean,** operating superintendent, is appointed assistant refinery manager.

Mr. Lionel Fraser is to resign from the board of Babcock & Wilcox, Limited after the Annual General Meeting due to be held on May 26, 1960. **Sir Kenneth Hague,** deputy chairman, will succeed Mr. Fraser as chairman of the board from that date and **Sir Reginald Verdon Smith** has been appointed deputy chairman.

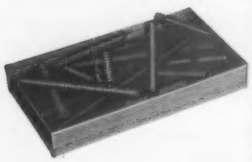
BABCOCK & WILCOX LIMITED also announce the following changes in staff appointments: **Mr. A. S. Peacock, A.M.I.Mech.E., M.Inst.F.,** is appointed purchasing controller; **Mr. J. S. Greenhalgh** has relinquished his appointment as purchasing controller to become manager, Construction Equipment Division. The headquarters of the new constructional equipment division will be in Lynton House, 7-12 Tavistock Square, London, W.C.1.

FERRANTI LIMITED announce the following appointments: **Mr. W. D. H. Gregson** has been appointed assistant general manager of the company's Edinburgh factory. **Mr. J. P. Newberry** succeeds Mr. Gregson as London Area Manager, and **Mr. P. McGregor** becomes senior transformer sales

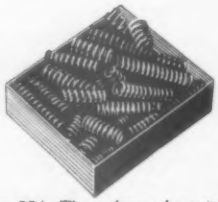
THAT *Experimental Spring* YOU WANT IS WAITING FOR YOU IN THIS BOX ...

No. 1217. One gross Assorted Springs. A complete Garage Service Kit. 42/- each.

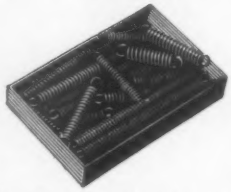
If not, try another box in the Terry Assorted Springs range



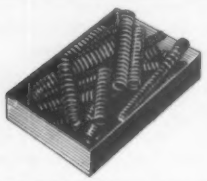
No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**



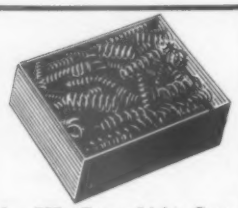
No. 98A. Three dozen Assorted 1" to 4" long, $\frac{1}{2}$" to $\frac{3}{4}$" diam., 19G to 15G. **5/6.**



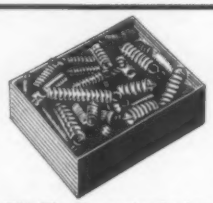
No. 753. Three dozen Assorted Light Expansion $\frac{1}{4}$" to $\frac{1}{2}$" diam., 2" to 6" long, 22 to 18 S.W.G. **10/6.**



No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long, 22 to 18 S.W.G., $\frac{1}{4}$" to $\frac{1}{2}$" diam. **6/6.**



No. 757. Extra Light Compression, 1 gross Assorted, $\frac{1}{8}$" to $\frac{1}{4}$" diam., $\frac{1}{2}$" to 2$\frac{1}{2}$" long, 27 to 19 S.W.G. **15/-.**



No. 758. Fine Expansion Springs. 1 gross Assorted $\frac{1}{4}$" to $\frac{3}{4}$" diam., $\frac{1}{2}$" to 2" long, 27 to 20 S.W.G. **15/-.**

We know *exactly* how difficult it is to find springs for experimental work . . . we've been making quality springs for over 100 years. So, we confidently offer you our excellent range of small boxed assortments which covers a very wide range.
We can only show a *few* boxes.
Send us a p.c. for our full list.
If ever you are stuck with a spring problem let our Research Department put their long experience at your disposal.

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HT30

engineer, London Area. **Mr. J. C. Heywood** has been appointed sales manager of the electronics department and is succeeded in the instrument department by **Mr. H. L. Harrison** as departmental sales manager.

Obituary

WE regret to record the death, at the age of 53, of **Mr. R. W. Harris,** director and general manager of Aircraft Steel Structures Limited, of Acton, a subsidiary company of Simms Motor & Electronics Corporation Limited.

WE regret to record the death of **Mr. H. W. Taylor,** production superintendent at the Ekco radio factory. Mr. Taylor, who was 51, joined Ekco in 1939 as a chargehand at the Southend factory.

Addresses

W. R. SKINNER LIMITED, service subsidiary of the Weir Group in London and South East England, has changed its name to Weir, Drysdale Service (London) Ltd. The address, at Caxton Street North, E16, remains the same.

APPLICATIONS and enquiries relating to import licensing should now be addressed to the Board of Trade, Tariff and Import Policy Division, Horse Guards Avenue, London, S.W.1. — Telephone Number, TRAfalgar 8855.

METALOCK (BRITAIN) LIMITED, London, have opened a branch in Birmingham at Windsor Chambers, Bearwood Road, Smethwick 41 (Telephone Bearwood 2799), under the managership of Mr. A. K. Hughes.

THE London branch office of Beldam Asbestos Company Limited and Auto-Klean Strainers Limited formerly at Wormwood Street, is now at 109 Fenchurch Street, EC3. Telephone No. ROYal 1148 (2 lines).

THE Bristol branch office of Brook Motors Limited is in larger and more convenient premises at the Refuge Assurance Building, 18 Baldwin Street, Bristol 1. The telephone number remains unchanged.

SGB BUILDING EQUIPMENT DIVISION is the new title of the Hire and Sales Division of Scaffolding (Great Britain) Limited. The Division's head office and works are at Mitcham, Surrey.

THE telephone number of the Erith Works of the Power Cables Division of British Insulated Callender's Cables Limited has been changed from ERITH 3030 to ERITH 33030.

A NEW branch office of Clarkson (Engineers) Limited has been opened in Coventry at 119 Leicester Causeway. Telephone number, Coventry 62724.

THE formation of a Hydraulic Servo Division is announced by Baldwin Industrial Controls, Baldwin Instrument Company Limited, Lowfield Street, Dartford, Kent to offer a comprehensive service for the application of hydraulic servo techniques to problems of production and experimental engineering. Mr. J. C. Wells is chief engineer of the new division.

Contracts and Work in Progress

AEI-BIRLEC LIMITED, Erdington. Two continuous pusher furnaces for annealing malleable iron for whiteheart and blackheart castings respectively.

Contract for the supply, through Brefcon Limited, of two adsorption dryers and an inert gas generator of 15,000 c.f.h. capacity for new oil refinery in Brazil.

AEI (RUGBY) LIMITED. Contracts totalling almost £2m. for the supply of practically the whole of the electrical equipment for Colvilles new cold reduction plant at Gartcosh, near Ravenscraig, Scotland. For Colvilles new hot mill at Ravenscraig, AEI are to supply a large number of type MDX motors and various Ward-Leonard equipments for operating the overhead cranes.

AEI (WOOLWICH) LIMITED.—Contracts placed with AEI Telecommunications Division for 10,200 Centenary Neophone telephones by the Irish Posts and Telegraphs Department.

AEI LIMITED, Turbine-generator division.—Order for second 550-MW turbine generator set for C.E.G.B. Thorpe Marsh power station. Total contract value, £3¾m.

WINSTON ELECTRONICS LIMITED.—Order valued at £12,000 for the Winston-Green blood pressure follower received from North America, following the demonstration visit of the company's managing director and chairman, Mr. F. Winston Reynolds, and the technical director, Mr. Roger F. Laurence. Firm enquiries have also been received from over 350 American hospitals and medical schools.

WILLAIM BOBY & COMPANY LIMITED.—Awarded contracts valued at £16,000 for dealkalization/base exchange plants by George Wimpey & Co. Limited, for the Union Carbide works at Hythe, Hants.

ENGLISH ELECTRIC COMPANY LIMITED.—Comprehensive contract for all the electrical equipment in three steel rolling mills from Colvilles Limited for their new Ravenscraig plant.

FAWCETT PRESTON (M.I. GROUP).—Order for a thermatic extruder from an Italian cable manufacturing company, Romeo Porta, near Milan.

TAYLOR ELECTRICAL INSTRUMENTS OF Slough (M.I. group).—Orders for more than 4,000 of the new edgewise meters.

AVO LIMITED (M.I. GROUP).—Contract from the U.K.A.E.A. for the installation of the Criticality Incident Detection System.

BROOKHIRST IGRANIC (M.I. GROUP).—Order worth £50,000 from Colvilles Limited for 14 sets of magnet crane controls.

GRIFFIN & GEORGE LIMITED, Alperton.—Further order value £8000 for six gas-liquid chromatographic analysis apparatus received from China.

SCHLOEMANN AKTIENGESELLSCHAFT, Dusseldorf.—Contract placed by Appleby-Frodingham Steel Company Limited, Scunthorpe, for high-duty universal beam mill.

HEENAN & FROUDE LIMITED.—Order from AEI (Manchester) Limited for a second Froude DPX 345 D dynamometer.

MITCHELL ENGINEERING LIMITED.—Contract value £2m. from Richard, Thomas and Baldwin Limited for mechanical handling equipment for their new Spencer steelworks at Llanwern, near Newport.

HUMPHREYS & GLASGOW (Canada) LIMITED.—Construction work recently begun on a major extension to B.A.-Shawinigan's petrochemical plant at Montreal.

Business Developments

Trading Agreements

AN agreement is announced between Continuous Casting Company Limited of Weybridge, Surrey, and Low Moor Alloy Steelworks Limited, of Bradford, for technical collaboration. The latter company has developed continuous casting of stainless and alloy steels slabs, blooms and billets. Continuous Casting Company Limited, which is associated with Davy & United Engineering Company Limited and Newton Chambers & Company Limited, is a licensee for the BISRA processes of continuous casting.

A NEW company in Western Germany to be known as Mecano-Simmonds, G.m.b.H. with headquarters at Heidelberg, is announced by Simmonds Aerocessories Limited, Treforest, South Wales, a member of the Firth Cleveland Group. Formed for the purpose of manufacturing and selling Spire speed nuts and other fastenings, Mecano-Bundy G.m.b.H. is owned jointly by Mannesman A.G., Düsseldorf, tube-makers, and The Bundy Tubing Company of America, both of whom will be partners of Simmonds in the new enterprise.

Company Acquisitions

A SUBSTANTIAL interest in N. V. Roto-Finish Maatschappij, Rotterdamseweg 370a, Delft, Holland, has been acquired by

Roto-Finish Limited of Mark Road, Hemel Hempstead, Herts.

AMBER CHEMICAL INDUSTRIES LIMITED, 11a Albemarle Street, London W1, have disposed of their controlling interest in Charles H. Windschuegl Limited, merchants and importers, to Mitchell Cotts & Company Limited.

THE ordinary shares in Baird & Tatlock (London) Limited, have been acquired by Derbyshire Stone Limited of Matlock, who thereby control the subsidiary companies of Hopkin & Williams Limited, and W. B. Nicholson (Scientific Instruments) Limited.

Agents and distributors

RECENTLY appointed agents in the Middle East and Portugal for Teleflex Products Limited, of Basildon, Essex, are, respectively, Mapplebeck Limited of Beirut, Lebanon, and Henriques Barbosa & Sibra Limited, of Lisbon.

DELAPENA honing machines and equipment will in future be distributed in the United Kingdom under the joint managership of Burton, Griffiths & Co. Limited of Kitts Green, Birmingham, and Delapena & Son Limited, Cheltenham.

BRITISH BOILER ACCESSORIES LIMITED have entered into an arrangement with the Toronto Iron Works Limited of Toronto, Canada, for the sale of B.B.A. steam accumulators and helical coil heat exchangers in Canada.

BRITISH machine tools of ABMTM are now to be sold and serviced in America by Lapointe Machine Company of Hudson, Mass., a newly formed subsidiary of The Lapointe Machine Tool Company. At the company's headquarters ABMTM machines will be stocked and demonstrated, together with spare parts to meet possible emergencies.

Film News

One Jump Ahead.—This new Wolf industrial film demonstrates the potentialities of modern "universal" electric tools for heavy production and special work. The leading role is played by Mr. Raymond Baxter and the film was made in collaboration with four well-known engineering firms, in whose factories all the action sequences were shot under normal working conditions. Filmed in colour on the latest 16 mm Kodak Ektakrome stock, *One Jump Ahead* will be shown by Wolfs at engineering centres throughout the country. It will be supplied on loan free of charge as copies become available.

Esso Catalogue.—A new catalogue of Esso films has been published and is available on demand. Recent additions include *Hook, Line and Sinker*, a story of great-line fishing, *Your Petrol Today*, which, with animation, depicts the continuous research aimed at higher quality petrols, and *Rubber from Oil*, a story of the research which produced Butyl rubber.

Engineering Design as a Career

COPIES of a leaflet on "Engineering Design as a Career" are available free of charge from the Institution of Engineering Designers, 38 Portland Place, London W1. This has been prepared in response to the many requests received by the Institution for information about careers in engineering drawing offices.

A Career in Production Engineering

A NEW illustrated brochure, describing the opportunities available to boys in production engineering, and entitled "A Career in Production Engineering" has just been published by the Institution of Production Engineers. Copies may be obtained, free of charge, from the Institution at 10 Chesterfield Street, London W1.

High Temperatures

DEMONSTRATIONS of high temperature equipment using electricity were recently held by The Morgan Crucible Company Limited in collaboration with the regional electricity boards in the North West. A number of furnaces operating at temperatures illustrated the versatility of Crusilite furnace heating elements.

Work Study School

THE Work Study School at Cranfield has just issued its revised brochure containing the list of courses and showing the comprehensive programme offered for the training of men who are intended to take responsibility for work study function, either as managers or as senior practitioners. Enquiries should be addressed to the Director of Studies, The Work Study School, Cranfield, Bletchley, Bucks.

60th Anniversary

THE dinner held in December to commemmorate the 60th anniversary of the founding of F. W. Brackett & Co. Limited, water screening engineers of Colchester, was accompanied by the presentation of gold watches to workers with more than 25 years' service, and all present employees received a barometer. Concessions in working hours were announced and extended holidays with pay according to length of service.

Trade Literature

Bowaters in North America

The opening of a new pulp mill by the Bowaters Carolina Corporation in the United States is the occasion for the publication by The Bowater Paper Corporation Limited, Knightsbridge, London SW1, of a brochure describing the activities of the corporation in North America, where Bowater plants now range from Newfoundland to Tennessee, the firms timber operations stretch from Labrador to the Mississippi, and research has seen its teams at work as far apart as South Carolina and Oregon. In Tennessee is the biggest newsprint plant in the United States, and the biggest British-financed venture to be established in America in twenty years. The new pulp mill on the Catawba river occupies 1300 acres and cost $38 million.

Burnerd "Multisize" Collet System

The Burnerd "Multisize" collet system comprises a completely new range of workholding and toolholding equipment. The collets are standardized in only six external size ranges and each collet has a gripping range of $\frac{1}{8}$ in., and the system extends from $\frac{1}{16}$ in. to $2\frac{1}{2}$ in. in a completely stepless range. In the tapered steel body are ground blades which exert a direct gripping action parallel to the workpiece over their whole length. For use with the collets there is a variety of lever operated dead length collet chucks, key operated chucks, table mounting chucks, toolholders, etc. The makers, F. Burnerd & Co. Limited, 5 Balfour Place, Park Lane, London W1, have issued a catalogue giving complete details of sizes and types for the complete system.

Corrosion

The cause and prevention of corrosion of ferrous metals in aqueous solutions with particular reference to boiler plants and cooling systems is the subject of Technical Publication No. 226 issued by the Feedwater Specialists Company, St. Paul's Square, Liverpool 3. Written by Mr. G. T. Peat, B.Sc., F.R.I.C., it gives a brief explanation of ionization and of the reactions which take place when metals corrode in liquids.

Twenty-five years of Stainless Steel

It is 25 years since Thos. Firth and John Brown Limited and the English Steel Corporation Limited, pooled their interests in stainless steel manufacture to form Firth-Vickers Stainless Steels Limited, of Sheffield. The anniversary is commemorated in issue No. 14 of the company's house journal "Enchiridion" by an illustrated review of achievements in a great variety of applications ranging from domestic equipment to power plant.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Cold Rolled Sections

The advantages of cold rolled sections for metal fabrication work in a wide variety of industries and the production facilities available at a modern plant are described in a new illustrated brochure issued by Warwick Rim & Sectioning Company Limited, Gold Green, West Bromwich, Staffs, pioneers in this country of the cold rolling process. The brochure shows how complex shapes can be produced to very close limits enabling the designer to avoid using separate components by incorporating them in one section. It also shows how composite sections, using dissimilar materials, can be produced. Various applications of the process are illustrated and details are given of ancillary services which are available. Copies of the new publication can be obtained direct from the company at the above address. Warwick Rim & Sectioning Company Limited, is a member of the Brockhouse Organization.

Electrically Released Magnetic Brake

Crofts' Type B brake remains normally engaged under pressure exerted by springs, and is released when required by energizing an electromagnetic system built into the brake housing. Its construction and method of working are described and instructions for mounting and dismantling are given in a new leaflet (Publication 5917) obtainable from the makers, Crofts (Engineers) Limited, Bradford 3, Yorkshire.

Manufacturing Capacity

Adams Bros. & Burnley Limited, Elmgrove Road, Harrow, Middlesex, are accustomed to taking on production work which manufacturers cannot conveniently handle themselves, whether experimental jobs or large contracts for the production, assembly, packing and despatch of complete units. The facilities available are described in a new folder in full colour and embrace toolmaking, sheet metal work of every variety, welding, polishing, plating, bonderizing and parkerizing, and painting, including the electro-static process.

Endurion

A simple immersion process which imparts to the zinc phosphate "Parkerized" surface of ferrous metals a dense, fine-textured, corrosion resistant finish with some improvement in wear resistance accompanied by almost negligible dimensional build-up, goes by the name "Endurion". It has already achieved considerable success in the U.S.A. for a number of applications, being widely used by American industry and specified for the U.S. military services. Now, by arrangement with the B.B. Chemical Company Limtied, Leicester, The Pyrene Company Limited are able to supply the chemicals and finishes required and have set out the relevant information in a bulletin which can be obtained from their headquarters at Great West Road, Brentford, Middlesex.

New Conveyor Beltings

During the past few months, George Angus & Co. Limited, Angus House, 152–158 Westgate Road, Newcastle upon Tyne 1, have added two important new constructions to their widening range of conveyor belting. These are Gaflex Nylon Wefted and Maxslope rough top, and full details concerning them are set out clearly in a new catalogue which is now available from the company at the address given above. The publication is also a reference booklet and gives much useful information on various aspects of belt selection, running and maintenance.

Melting Point Apparatus

A new electric melting point apparatus has been developed by Electrothermal Engineering Limited, 270 Neville Road, London E7. It has a range of 20° C to to 360° C and an accuracy of ± 1° C. Transformer and controls are in the base of the instrument and the heater block in a casing at a convenient height for viewing through the illuminated optical system provided. The block has a central hole for a thermometer and three equidistant holes for capillary tubes. The apparatus is fully described and illustrated in a folder available from the makers.

Mechanical Seals

Flexibox Limited have produced a new comprehensive mechanical seal catalogue primarily designed to provide users with a rapid means of selecting the correct type and size of seal for any given application. To this end tables of essential dimensions, operating limits, power absorption and frictional heat development nomograms and details of PV ratings have been included. In addition a recommended materials specification for seal components is given for more than 350 fluids. Copies of the new catalogue are obtainable from Public Relations Department, Flexibox Limited, Nash Road, Trafford Park, Manchester 17.

Surface Grinding Machine

The Model 1400 surface grinding machine made by A. A. Jones & Shipman Limited, Leicester, is now fitted with a power rise and fall to the wheelhead as standard, and automatic down feed to the head is available as an optional feature. The machine is fully described and illustrated in a new brochure (No. 237H) available from the company.

Electrolube

A leaflet from Holiday & Hemmerdinger Limited, 71 Ardwick Green North, Manchester 12, describes "Electrolube" a complex, low carbon liquid composition which increases the electrical conductivity between conducting surfaces—switch contacts and the like. The material penetrates oxide, sulphide and other chemical films without attacking the chemical surfaces.

Flashing Beacon

In the new "Moflash" beacon a penetrating signal in red or amber is given by a special neon tube mounted in a plastic dome. The flashing rate of 80 per min accelerates when the six torch batteries are nearing exhaustion, so giving warning. Running cost is 3d for 24 hr. Details are given in a new leaflet obtainable from the makers, The Silvaflame Company Limited, 218a Monument Street, Birmingham 16.

New Factories

Aycliffe (Co. Durham). E. N. V. Engineering Company Limited. Kleeman Plastics Limited. Factory extensions. Architects are Cordingley and McIntyre, Owengate, Durham City.

P. B. Kent and Company Limited. The builders for office extensions are Lax and Sons, West Road, Crook; Ward Brothers, Sherburn, Yorkshire are the contractors for factory additions.

Berwick. Pringle of Scotland Limited are to extend their factory on Tweedmouth trading estate.

Blaydon (Co. Durham). Mr. Fillis, Newburn Road, Throckley, is seeking planning permission to construct a factory on a former football ground near Patterson Street for the making of precast concrete, concrete blocks, and stone.

Carlisle. F. Jackson, Lowther Street, Carlisle, has prepared plans for development in Castle Street including the erection of printing works.

Darlington. Tin Boxes Limited and F. Bookless and Company Limited. Plans for factory additions approved.

Fence Houses (Co. Durham). Bursgreen Limited, woodworking machinery manufacturers. Factory additions proposed. Builders, W. Norman, 3 West Lane, Chester-le-Street; architects, Mauchlen, Weightman and Elphick, 12 Saville Row, Newcastle upon Tyne.

Jarrow (Co. Durham). A Leicester firm of pumping engineers are enquiring into the possibility of starting a factory at Jarrow.

Middlesbrough. Middleton and Company, manufacturing chemists, Boundary Road, are erecting new warehouses, offices etc. The contractors are Charles Tennet and

(*Continued over*)

Company, Church Road, Stockton-on-Tees.

Newcastle upon Tyne. Black and Decker Limited are to construct workshops and offices in George Street. The architect is M. Gatoff, 26 Mosley Street, Newcastle upon Tyne.

Scarborough. Dennis and Sons. New machine room for printing works at Melrose Street. Plans prepared by G. W. Alderson, 4 Pavilion Terrace, Scarborough.

South Bank-on-Tees. Smith's Dock Company Limited are considering scheme for the construction of a new dry dock 1,000 ft long and 135 ft wide.

South Shields. Frys Diecastings Limited. The contractors for proposed factory additions on Bede Estate are Randle and Company Limited, Back Dunelm, Sunderland. The architects are George H. Gray and Partner, 8 Portland Terrace, Newcastle upon Tyne.

Wright and Weaire Limited. Work has started on a small factory extension at the Simonside Works. The builders are Tate and Holmes Limited, Benwell, Newcastle upon Tyne.

Newman's. Factory extensions of about 6,000 sq ft to plans by Jack Cotton, Ballard and Blow, Haymarket House, Newcastle upon Tyne.

Spennymoor. Thorn Electrical Industries Limited. The contractors for the erection of new factory are G. Stephenson (Contractors) Limited, Bishop Auckland. The architects are Fennell and Baddiley, Bridge End Chambers, Chester-le-Street, Co. Durham.

Sunderland. Ericcson Telephones Limited and the Gresley Machine Company Limited. Factories at Pallion, Sunderland, are to be extended by North-Eastern Trading Estates Limited, Team Valley, Gateshead.

Wallsend. Commercial Plastics Limited, Stephenson Street, are to erect laboratory block and factory building. Plans approved.

Whitby. Halls (Contractors) Limited, Baxtergate, are to erect a wrought iron factory and joiners' workshop at Ruswarp and plans have been approved.

Ayr. James Gilchrist Limited, 14 Boswell Park. To erect a new factory at Heathfield.

Barrow-in-Furness. British Cellophane Limited. Extensions to their recently built factory.

Belper. The English Sewing Cotton Company Limited, Arkwright House, Blackfriars, Manchester 3, are to demolish Round Mill and erect a new factory.

Birmingham. Turner Bros. (Birmingham) Limited, Cliveland Street. A new factory is to be erected in New Sumner Street.

Bolton. Pilot Works Limited, Manchester Road. Extensions to Works.

Angle Bank Welding Company Limited, Extensions to the factory in Ninehouse Lane.

Bootle. Reckitt & Sons Limited, Damson Lane, Hull. Extensions to their premises in Laftwith Road.

Cardiff. Plasterers (Chester & Liverpool) Limited, Taff Terrace, Radyr. To build a new factory on Penarth Road Industrial Estate.

Croydon. Tool & Production Company Limited, 40 Spring Lane. Works extensions.

Dagenham. Harmer & Simmons Limited, Fowler Road, Hainault. Extensions to works. The architects are C. Living & Sons, 233 Leytonstone Road, London E15.

Dawley. Pyjamas Limited, Park Road. Factory extensions.

Eastbourne. Edwards High Vacuum Limited, Manor Royal, Crawley, are considering the erection of a new factory at Brampton Road Trading Estate.

Eccles. Georgeson & Wood Limited, Monton Knitting Mills, Rocky Lane, are to make extensions to their works.

Edmonton. Rayner & Co., Commercial Road. Extensions to factory.

Fareham. Searle Radiator & Refrigeration Limited. The factory at Newgate Lane is to be extended.

Glasgow. Thermotank Engineering Limited, Helen Street, Glasgow SW1. Extensions to works.

Hastings. Central Engineering Works Limited, Woodlands Works, The Ridge, St. Leonards-on-Sea. New factory.

Hull. T. Holmes & Sons Limited, The Tannery, Sculcoates, are to erect a new factory at Air Street.

Irthlingborough. F. Norton & Son Limited, Excelsior Works. Extensions are to be made to the factory.

Kendal. The K Shoe Company, Netherfield, are to erect a new factory.

Kilroot, Co. Antrim. Imperial Chemical Industries Limited, Millbank, London SW, are to erect a factory for the manufacture of Terylene.

New Factories

Liverpool. James Neill (Sheffield) Limited, Napier Street, Sheffield 11, are to erect a new factory at Speke Hall Road.

Radiovim Limited, Northumberland Street, are to build a factory at Newhall Street.

London. Trafalgar Fancy Box Company Limited, 16 Hillborough Road, London E8. The architects for the new factory to be built at Prichards Road, London E, are Lovegrove & Lindars, 374–378 Old Street, London EC1.

Manchester. Remploy Limited, 25 Buckingham Gate, London SW1, are to build a new factory at Leestone Road, Sharston.

Newport, I.o.W. Lukely Engineering Company Limited, Carisbrooke Road, Extensions to works.

Portchester. J. H. Sparsnott & Sons, (Portsmouth) Limited, London Road, Hilsea, are proposing to erect a new factory at Roman Drive.

Portsmouth. Wiping Cloth Limited, 13 St. James Street, Portsea, are to rebuild the factory in St. James Street.

Ramsgate. Nelbarden Manufacturing Company Limited. The architect for the new factory is W. W. Garwood, Lomeer Lodge, Winterstoke-Way. S. R. Bowell & Son Limited, Herne Bay, are the contractors.

Salford. Modern Methods Engraving Company, 23a Garden Lane, Manchester 3. Plans have been provisionally approved for the erection of a new factory.

St. Albans. Marconi Instruments Limited, are to extend their factory at Longacres.

Stoke-on-Trent. Neckwear Limited, Commerce Street, Longton. Sanction has been received to extend their factory.

Surbiton. Fine Tubes Limited, Extensions are to be made to the works at King Charles Road.

Swansea. Rees & Kirby Limited. Extensions are to be made to the works in Foundry Road, Morriston.

The Servitor Brush Company Limited are to extend their factory on the Trading Estate, Fforestfach.

Treforest. K. L. G. Sparking Plugs Limited. Extensions to factory.

Wakefield. British Jeffrey Diamond Limited, Thornes Moor Road. Factory extensions.

Walsall. T. Gameson & Sons Limited, Tinning Works, Dudley Street, are to remove their factory to a new site.

Watford. Faksin Photo Limited, Sydney Road, are to make extensions to their factory.

Annan. Scottish Weyroc Company, a subsidiary of Airscrew Company and Jicwood Limited of Weybridge, have received planning permission for a new chipboard factory at Creca, near Annan. They already have a factory at work in Annan, two miles from the present site.

Ayr. Alexander Ferguson Limited, engineers and brassfounders of Glasgow, are to build a light engineering works at York Street, Ayr.

Bathgate. Telegraph Condenser Company Limited who make condensers and transistors are to extend their Whiteside works at Bathgate by 50,000 sq ft.

Following the B.M.C. decision to locate at Bathgate three Birmingham area firms are seeking sites adjoining for the manufacture of components and equipment for the industry.

Blantyre. Smith Tool Company of Los Angeles are to take over a factory at Blantyre Industrial Estate formerly used by Rolls Royce to manufacture a range of tools, on the lines handled by the H. C. Smith Tool Company in the U.S.A.

Glasgow. Scottish Agricultural Industries Limited have modernized their Nutrimol Mill, bringing it under push-button control methods, at a cost of £400,000.

Grangemouth. The Town Council has planned a 62 acre industrial estate with unit factories from 800 to 10,000 sq ft for rent at 3s. per ft (or for sale).

Granton. Regent Oil Company Limited are to locate a £500,000 oil terminal at Granton on the Firth of Forth. They will provide storage for 30,000 tons of oil and will lay down 3,000 ft of cargo pipeline to link up with the deep water berth at the West Pier.

Hawick. Wilson and Glenny Limited of Hawick whose premises were destroyed by fire a few months ago have been given approval for a modern unit costing £160,000.

Irvine. Wilson Pipe Fittings Limited of Fordneuk Street, Glasgow, and William McCoard and Son of Whitevale Cotton Mills, Millerston Street, Glasgow, are to transfer to the new industrial estate at Irvine.

Johnstone. Renart Manufacturing Company Limited have bought premises in South William Street, to start production of window blinds.

Kilmarnoch. Douglas, Rayburn and Company Limited of Mill Street, are to erect a £14,000 extension.

Motherwell. Colvilles Limited have doubled the original plans for their strip mill at Ravenscraig which will now provide 500,000 tons per annum at a cost of £10,500,000.

Northern Ireland. The Northern Ireland Development Council have leased a 30,000 sq ft advance factory at Lurgan, Co. Armagh, to the Industrial Accountancy Partnership Limited of London, a member of the Trubenised (Great Britain) Limited Group. The C.W.S. has taken a substantial shareholding in the company.

Wilkinson and Co. Limited of Nottingham, woven fibre furniture manufacturers, are to expand their Lurgan factory for the second time

A second factory of 6000 sq ft at Dunmurry, nr. Belfast, has been allocated to Gascoignes (Reading) Limited for the manufacture of dairy equipment.

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Patents For Sale or License

THE proprietor of British Patent No. 682213, entitled "Forming Roll Machine" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 759094, entitled "A Gate Valve Assembly", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14E. Jackson Blvd., Chicago 4, Illionois, U.S.A.

THE proprietor of British Patent No. 761002, entitled "Method and apparatus for casting metal battery parts" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Calberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 757181 entitled ,'Improvements in Screw Anchorages," offers same for license or otherwise to ensure its practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, Chrysler Building, New York 17, New York, U.S.A.

THE proprietor of British Patent No. 760453, entitled "Improvements in shaft sealing devices" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 657949, entitled "Flareless Tube Coupling" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

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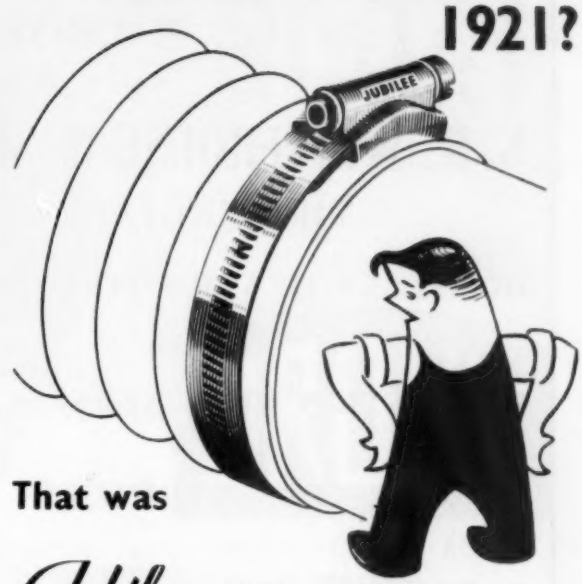

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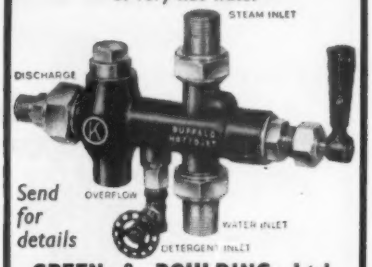

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the designers problem...

the right metal for the job

correct metal selection
is the key to good casting performance

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The Meehanite Metal Selection Chart has been produced to meet this problem.

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